MINING engineering

NOVEMBER 1961

COMING EVENTS

Nov. 13-15, Steel Founders' Society of America Technical and Operating Conference, Hotel Carter, Cleveland.

Nov. 29-30, Michigan State University College of Engineering, Effective Utilization of Engineering Personnel, Kellogg Center, East Lansing, Mich.

Dec. 4, Annual Meeting Arizona Section of AIME, Pioneer Hotel, Tucson, Ariz.

Dec. 4-5, New York University, Beryllium Conference, New York City.

Dec. 6-8, Nineteenth Electric Furnace Conference, sponsored by The Metallurgical Society of AIME. Penn-Sheraton Hotel, Pittsburgh.

Dec. 9-12, Mechanization of Mines in India—Symposium, Central Mining Research Station, Dhanbad, India.

Jan. 15-17, 1962, AIME Minnesota Section Annual Meeting-University of Minnesota 23rd Annual Mining Symposium, Hotel Duluth, Duluth.

Feb. 18-22, AIME Annual Meeting, Statler-Hilton & Astor Hotels, New York City.

Mar. 12-13, Steel Founders' Society of America Annual Meeting, Drake Hotel, Chicago.

Mar. 26-29, AAPG-SEPM Annual Meeting, jointly with AAPG-SEPM-SEG Pacific Sections, Civic Auditorium, San Francisco. Fairmont Hotel to be hotel headquarters.

Apr. 5-6, ASME-SAM Management Engineering Conference, Statler-Hilton Hotel, New York City.

Apr. 9-11, 45th National Open Hearth and Blast Furnace, Coke Oven and Raw Materials Conference, sponsored by The Metallurgical Society of AIME. Sheraton-Cadillac Hotel, Detroit.

Apr. 9-13, ASME Metals Engineering Conference, Sheraton Cleveland Hotel, Cleveland.

Apr. 12-14, AIME Pacific Southwest Mineral Industry Conference, Palace Hotel, San Francisco.

Apr. 23-25, 12th Annual Meeting, Rocky Mt. Section, AAPG, Salt Lake City.

Apr. 26-28, AIME-ASM Pacific Northwest Metals and Minerals Conference, Ben Franklin Hotel, Seattle, Wash.

May 3-5, 5th Rock Mechanics Symposium, University of Minnesota, Minneapolis.

May 7-9, American Mining Congress Coal Convention, Pittsburgh.

May 7-11, American Foundrymen's Society 66th Annual Castings Congress & Exposition to be held in conjunction with the 29th International Foundry Congress, Cobo Hall, Detroit.

May 11-13, Seventh Annual Uranium Symposium, sponsored by the Uranium Section of AIME, Moab, Utah.

May 28-June 1, 4th International Coal Preparation Congress, Harrogate, England.

June 4-6, 1962, Nuclear Congress and Atomic Exposition, New York Coliseum, New York City.

June 7-8, AIME Coal Division Field Meeting, Price, Utah.

Sept. 9-13, SME Fall Meeting, Gatlinburgh, Tenn.

Sept. 13-14, Joint Engineering Management Conference, Roosevelt Hotel, New Orleans, La.

Sept. 17-20, SEG, 32nd Annual International Meeting, Calgary, Alta., Canada.

Sept. 24-26, ASME-AIEE National Power Conference, Lord Baltimore Hotel, Baltimore, Md.

Sept. 24-27, AMC Mining Show: Metal Mining—Industrial Minerals, San Francisco.

Oct. 20-26, Sixth World Power Conference, Melbourne, Australia

SOCIETY OF MINING ENGINEERS AIME

MINING engineering

VOL. 13 NO. 11 **NOVEMBER 1961**

COVER *Unique headframes are a trademark of mining in South Africa. At the recent Seventh Commonwealth Congress on Mining and Metallurgy, A. C. Backeberg discussed concrete headframes employed in this region. Portions of his paper has been extracted and presented on page 1240. Cover artist Herb McClure has dramatically portrayed the Reibeeck headframe in Transvaal on this month's cover.*

ARTICLES

PLUS

DEPARTMENTS

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed with "The Drift Of Things". Number of copies printed of this issue: 15,600.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include 8¢ in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18;** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Assistant Superintendent or Foreman—open pit, B.S. in mining and engineering. Eight years underground experience as engineer, shift boss, foreman which includes supervision in room and pillar trackless operation, large bore tunnel driving, block cave mine development and underground construction. Prefer western U.S. M-630.

Soils Engineer, B.S. in geological engineering, age 30. Approximately five years in civil engineering of which two have been in soil and foundation work. Midwest or foreign. M-2285-Chicago.

Manager, Superintendent-Mining, mining engineering, age 42. Broad experience in mine management and supervision, exploration, engineering, engineering valuations, feasibility studies. Training in business, accounting, industrial management. $12,000. Any location. Home: California. Se-1149.

Manager, Nonmetallic Mine, mining engineering, age 44. Sixteen years gypsum industry, including six years as plant manager of complete plant and quarry. Four years engineering underground copper mines. Two years instructor mining engineering. $800. Any location. Home: New Mexico. Se-1323.

Foreman, Superintendent-Mine, mining degree in England, age 33. Ten years in block caving cut and fill and square set stoping operations in gold, copper, lead, zinc, silver. Engineering, eight years production in South America and Philippines. $700. Prefer underground, metal mining. Foreign. Home: England. Se-1503.

Mine, Mill-Metalliferrous, mining, metallurgical engineering, England, age 55. Registered P. E. in Africa. Eleven years mine, mill, metallurgy. Design, construction of gravity concentration mill for beneficiation of chromite and mill for cyanidation, flotation, concentration overseas. $600. Prefer foreign. Home: California. Se-1303.

Mining or Petroleum Engineer, B.S. in mining engineering, age 31. Seven years experience—six with integrated major oil company in Venezuela including two-year training program for petroleum engineers, one year on artificial lift studies, one year on reservoir engineering, two years on waterflood plant design and liaison engineering. Worked summers at major western gold mine and geophysical crew. Prefer northeastern U.S. M-629.

Appraiser, Geologist-Mineral, M.A. and Min.E. degrees, age 62. Registered P. E. Management operating mining properties. Experience in cyanidation, selective flotation. Mine inspection and appraisal of mining properties. Geological reconnaissance. Engineering geology investigations. Salary open. Prefer California. Home: California.

POSITIONS OPEN

Engineers. a) *Mining Engineer-Field Examiner,* graduate mining engineer, age to 40, for exploring, preparing reports, making recommendations on nonferrous properties. Must have open pit mine operating experience. $9,600 to $10,800. **b)** *Mining Engineer,* to take charge of field work. Will be responsible for surveying, drilling and examination crews. Must have overseas experience, preferably South America. Knowledge of French helpful. Salary open. Employer will pay fee. French Guiana. C8792.

Field Examiner-Mine Property, graduate mining engineer, age 30 to 40. Prefer open pit mine operating experience. Explore, examine, report, recommend, evaluate existing metallic (nonferrous) properties. Number two man, run survey, drill and examination crews, in charge of field work on definite properties. Must have overseas experience, preferably South America. Speaking knowledge of French helpful. $800 to $900 a month, in French Guiana. Sj-6386.

Metallurgists-Concentrator, metallurgical background, age to 35. Three to five years in or related primarily to copper ore concentrator methods improvements, will test float, grind, reagent, acid-lime function for maximum recovery and efficiency. For a mine mill. $750 a month, in Arizona. Se-6405.

Superintendent-Mill, mining, milling background, age open. Some experience in supervising and designing mill facilities and operations. To supervise small crew in base metals selected flotation mill located near town. $600 up a month, in Oregon. Sj-6344.

Sales-Mine, Mill, MinE., M.E., Met. degree, age to 32. Two years in process plant as assistant superintendent or foreman; on clarifying, ball mills, dry or wet process. Train one or two years in eastern plant, return to San Francisco to cover Pacific Coast, Arizona and Nevada. For a manufacturer of heavy mill type machinery. $600 a month, in San Francisco.

Geologist-Metals, age 25 to 30. Several years exploring preferably large area, know deposits, iron, field, camping; work with field crew, single status. One year, possibly renewable contract, transportation out and return in one year, estimate four or five years work. For an American company. $550 plus a month, in Australia. Se-6423.

Miner-Open Pit, graduate mining engineer, young. Two years experience. Will train in open pit operations. Assist in exploration (survey, map, report, claim), assist in planning, develop into operations and production man, develop with a young, growing, well financed company, initially as a mining engineer on a staff of geologists. For a minerals company. To $550 a month, in Wyoming. Sj-6366.

Mining Engineer with several years experience in iron ore mining for responsible position with large company. South America. F805.

Mine Engineer, graduate mining engineer with about five years experience in underground mining, preferably in open stope operations. Salary open. New York State. W766.

Project Engineer, graduate mining, chemical or mechanical engineering, experienced in mineral dressing, crushing, grinding, classification, roasting and drying of minerals and materials, to perform these functions as required in the preparation of abrasive grains and powders. Apply by a letter stating salary desired. Upstate New York. W541.

Mine Superintendent with at least 10 years supervisory open pit and underground copper mining experience. Salary open. Near East. F481a.

Mining Engineer, young, with experience on stripping operations for pegmatite project. $8000. Brazil. F352.

Mining Engineer, Ore Research, B.S. or M.S. degree required, for research investigations and analysis of problems in concentration, beneficiation and agglomeration of iron ore. Desire up to five years experience in ore research laboratory. Salary commensurate with training and experience. Employer will pay fee, Northern Michigan. C8816.

Industrial Mining, degree in mining engineering, to 50. Five years industrial engineering to supervise industrial department of mechanized underground copper mine. For major mining company. $10,000. Northern Midwest. Sj-6485.

Top Superintendent-Mill and Mine, degree in mining engineering. Ten years up mill and mine work, deal with Spanish native forces, improve operations, increase production, reduce cost in 100-tpd tungsten mill and mine, 15,000 ft. Opportunity to develop other properties. For producing company. $12,000 plus. Bolivia. Sj-6550.

Draft-Geological, geology background, to 50. Some geological drafting, do ink drawing on acetate film or linen. Knowledge of LeRoy lettering and mineral mining. Freehand lettering desirable. For exploratory mapping. $450. San Francisco. Sj-6552.

LETTERS

Highest Golf Course?

Dear Editor:

Having recently completed a nearly all bus trip from Lima to Caracas and to Barranquilla, Colombia, I can appreciate the pleasure you gained in your South American overland trip.

However, there is one minor item in your enjoyable story which I would like to question. It concerns the highest golf course in the world. I believe it is the one—nine holes of standard length— at Condoroma mine in the SW part of Cuzco Department (State), Peru. It is at something over 16,000 feet above sea level. Hazards include spectators who often watch from the fairways, women washing clothes in the water hazards, and grazing llamas.

Yours very truly,
L. W. Cope

Dear Editor:

Today I finally got a chance to glance over the August MINING ENGINEERING and noted with interest your articles in the "Drift." The note on comparative altitude and length of the Aguilar golf course is worthy of comment since there are at least three others which are probably just as high or higher. These are the ones at Cerro de Pasco and Morococha, Peru, and at Catavi, Bolivia. The comparative lengths of these courses is something I am not sure about, but the ones in Peru are well above 13,000 elev. and the one at Catavi (actually nearer Siglo XX) is very likely over 13,000. They all have one thing as a common characteristic besides altitude and that is that they

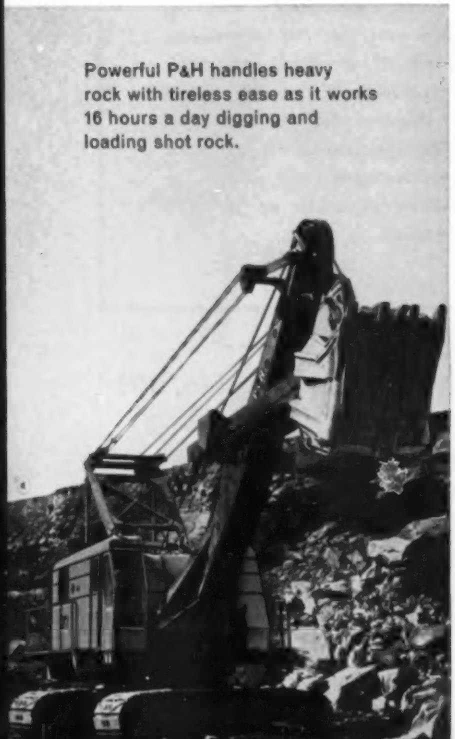
(Continued on page 1199)

Making short work of loading truck, 4-yard P&H makes complete work cycles in 12 seconds.

Magnetorque swingers are the reason . . .

"4 yard P&H out-produces two 2½ yard shovels"

. . . STOCKBRIDGE STONE COMPANY, Atlanta, Georgia
Division of VULCAN MATERIALS COMPANY



Powerful P&H handles heavy rock with tireless ease as it works 16 hours a day digging and loading shot rock.

J. G. Lambert, Superintendent, has this to say about his operation— "*Our 4 yard P&H shovel, with Magnetorque swingers, accounts for more than half of the yardage produced at our Fortson quarry. It actually produces more than both of our other 2½ yard shovels combined.*"

12 to 15 seconds work cycles. Stockbridge Stone supplies aggregate throughout Georgia, Alabama, and to four company-owned plants that manufacture concrete blocks and ready-mix. Of prime importance to them is the speed and dependability with which their shovels can excavate rock and load trucks to keep their processing plants in production. This company reports that their P&H shovel loads 18-ton trucks in 5 or 6 passes with work cycles averaging 12 to 15 seconds.

Edward Pitts, operator of the P&H says that Magnetorque swingers are the reason he gets better than 25% faster work cycles. He points out that Magnetorque swingers, unlike friction-type clutches, never over heat, and are not affected by temperature changes or load size.

P&H works two 8 hour shifts per day. To meet the heavy demand for aggregate, Stockbridge operates their 4-yard P&H shovel on a 16-hour day . . . and they operate in all types of weather, even the heaviest rains. This company has proven to itself that P&H delivers exceptional performance under the most rigorous conditions—steady, fast cycles with no downtime other than normal preventive maintenance.

Another feature, "Bud" Lambert stresses, is the propel brake on the P&H—this brake control gives more productive working time because it eliminates the constant need to "dog" or "undog" the machine with clumsy jaw clutches for every move.

For more information on this job, write for Case History 136.

HARNISCHFEGER P&H
Milwaukee 46, Wisconsin

Circle No. 4 on the reader service card.

AGELESS AKINS

1934 Akins Simplex Classifier still giving Dependable Performance for Virginia-Carolina Chemical Corp.

The 78" Akins Simplex Classifier, built in 1934, is dewatering coarse feed in a special flotation circuit. The new 72" Akins Duplex Classifier, with flared tank and serrated shoes, is dewatering and desliming flotation feed. Photo shows three of more than 200 Massco-Grigsby Pinch Valves purchased by Virginia-Carolina Chemical Corporation.

Working Beside New Akins Duplex

The 78" Akins Simplex Classifier, built in 1934 for a large mining company, was acquired by Virginia-Carolina Chemical Corporation in 1956. Based on its dependable and efficient operation the company purchased a 72" Akins Duplex Classifier and a 60" Akins Simplex Classifier for its Clear Springs phosphate plant in Florida. These classifiers were sold and serviced by Mine and Smelter's Sales Agent, R. H. Clark Equipment Co., Inc., Mulberry, Florida.

"Ageless" Akins Classifiers, for washing, desliming, dewatering, size separation, and closed-circuit grinding, are available in sizes from 12" to 84" spiral diameter, simplex and duplex, with standard or submerged spiral. Sand raking capacities up to 7860 tons per 24 hours; overflow capacities up to 2386 tons per 24 hours.

For complete information write for Catalog No. 601

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The drilling speed of a drifter . . . combined with the greatest handle-ability ever built into feed leg drills . . . bring top drilling performance to your underground workings. Put one to work in your own mine, and compare these outstanding Gardner-Denver advantages:

- Fast-acting, drifter-type valve
- Centralized, one-hand controls
- Retractable feed legs, telescopic or standard
- Seven travel lengths from 2′ to 5½′
- Adaptable for use as a drifter or stoper, or on sinker drill applications.

See your Gardner-Denver Rock Drill Specialist . . . or write for details on the complete line of Gardner-Denver Air Feed Leg Drills.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

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How planet-drive "25"

stripping . . . ripping .

To make full-load turns, you simply change the speed of either TD-25 track with "live-track" Planet Power-steering. This way, you keep full power and traction on both tracks, *full time*. You get rid of load-limiting, profit-squeezing "dead-track drag."

To handle big offset loads, or to counteract the side draft of benching or highwalling, without sluing or bank-nosing, is finger-tip easy. Just shift the TD-25's load-side track to high range; leave the other track in low. You stay on course, deliver full loads or make full cuts under full power.

To keep full loads on the move, full time through tough or easy going, use instant-acting, on-the-go Hi-Lo power-shifting. Pit-to-hopper matching of power to condition helps "keep the heap"—extends effective dozing distances—cuts down on payload spillage. Fast, easy TD-25 power-shifting is a built-in bonus of Planet Power-steering!

And only the International TD-25 gives you the 230 hp wallop of the free-breathing, dual-valved DT-817 diesel—with peak turbocharging efficiency at all altitudes.

Prove the profit advantage of full-load delivery, full time. See how consistently the TD-25 outproduces king-sized clutch-steered competitive rigs. Compare operating and upkeep economy, too. Let your International Construction Equipment Distributor demonstrate.

International® Construction Equipment

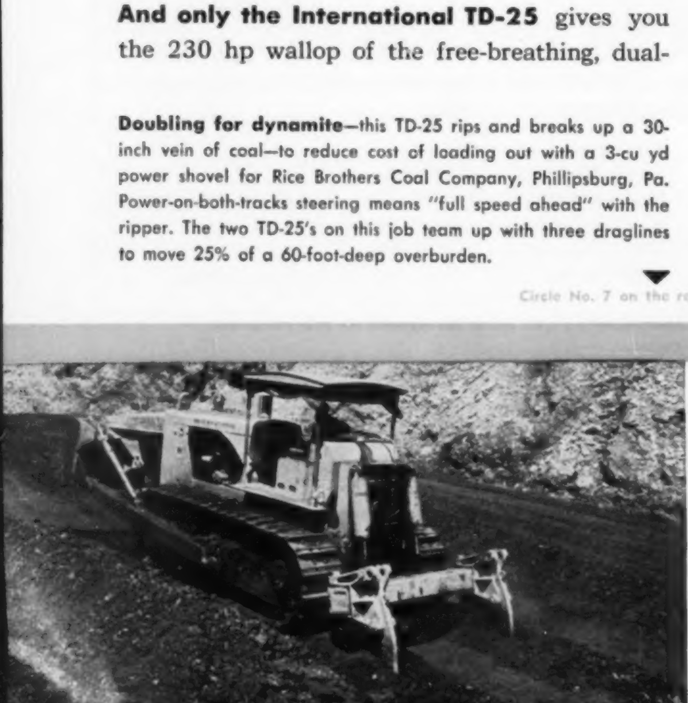
International Harvester Co.,
180 North Michigan Ave., Chicago 1, Ill.
A COMPLETE POWER PACKAGE

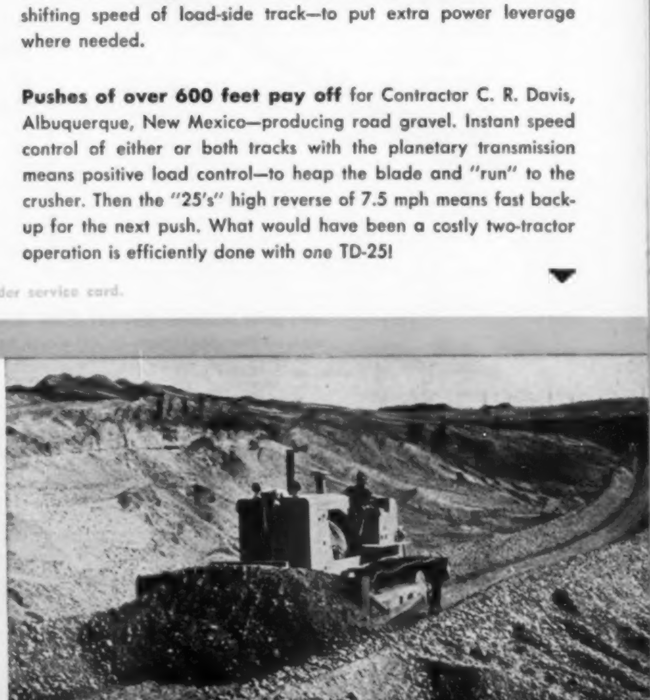
Doubling for dynamite—this TD-25 rips and breaks up a 30-inch vein of coal—to reduce cost of loading out with a 3-cu yd power shovel for Rice Brothers Coal Company, Phillipsburg, Pa. Power-on-both-tracks steering means "full speed ahead" with the ripper. The two TD-25's on this job team up with three draglines to move 25% of a 60-foot-deep overburden.

"Our International TD-25 doubles load delivery of regular 'dozer blade . . . using V-type blade on spoil leveling," reports Partner Carl Sartori, Willowbrook Mining Co., Slippery Rock, Pa. On-course steering with this heavy offset load is achieved by up-shifting speed of load-side track—to put extra power leverage where needed.

Pushes of over 600 feet pay off for Contractor C. R. Davis, Albuquerque, New Mexico—producing road gravel. Instant speed control of either or both tracks with the planetary transmission means positive load control—to heap the blade and "run" to the crusher. Then the "25's" high reverse of 7.5 mph means fast back-up for the next push. What would have been a costly two-tractor operation is efficiently done with one TD-25!

Circle No. 7 on the reader service card.





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..highballing loads!

Crush more tons per dollar . . .

BUY REPLACEMENT PARTS FROM THE COMPANY THAT BUILT YOUR CRUSHER

You buy a crusher because of the engineering experience the manufacturer has put into it to give you more production for your money. In the same way, the manufacturer of your crusher buys the experience and engineering abilities of the company which supplies certain components and replacement parts for it. The manufacturer profits only when *you* are satisfied with the performance of his product. That's why most big-name crushing equipment manufacturers work closely with AMSCO to give you replacement parts that fit perfectly, assure original equipment performance, and last a long time in the toughest conditions.

When it comes to wear parts, here's why most manufacturers insist on AMSCO. As long-experienced specialists in wear-resistant metals, AMSCO *engineers* alloys to exact formula needed to stand up under the abrasion-impact-pressure crushing conditions of your job. AMSCO cast parts are structurally perfect and contain the proper alloys for longest possible life.

AMSCO parts are patterned from manufacturer's drawings. They are built for *your* crusher . . . not copied from inaccurate field measurements. When you need mantles, concaves, jaws, rolls, plates or liners, get them from the manufacturer who built your crusher. He depends on AMSCO's experienced way with wear-resistant alloys *to help you crush more tons per dollar.*

They're backed by experience...

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IN CANADA: Joliette Steel and Manitoba Steel Foundry Divisions
IN MEXICO: Amsco Mexicana, S. A.

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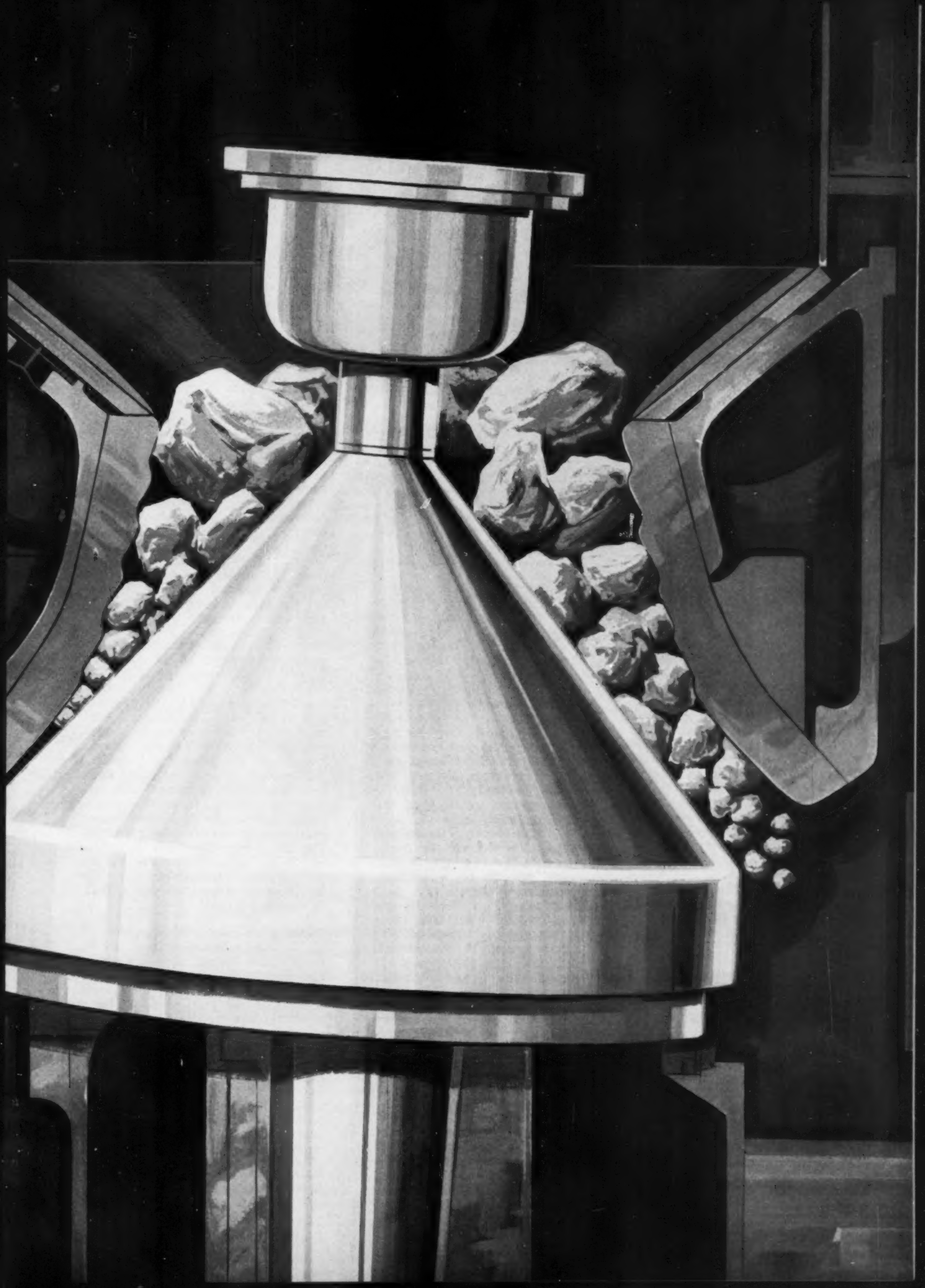


Mineral Information

An International Directory of Engineering Source Material

Order directly from the publisher all books listed below except those marked • • • The books so marked (• • •) can be purchased through AIME, usually at a discount· Address Irene K. Sharp, AIME Book Dept., 29 W. 39 St., New York 18, N. Y.

Quin's Metal Handbook 1960 compiled by Eileen Langford, *Metal Information Bureau Ltd.*, 27 Albemarle St., London W.1, England, 1961, 648 pp.—The 46th edition of this comprehensive statistical survey contains price records, production and consumption figures, destinations and sources, import-export data for ores, ferrous and nonferrous metals, scrap, ferroalloys, tin plates, etc. for numerous countries. This information is published for the years 1957 through 1959 with a special section on USSR trade statistics for 1958 and 1959.

Introduction to Engineering Mechanics by John V. Huddleston, *Addison-Wesley Publishing Co. Inc.*, Reading, Mass., 1961, 493 pp., $9.75—The fundamentals of mechanics are emphasized in this work which differs from similar texts in its selection and sequence of topics. The author has divided the subject on the basis of particles, rigid bodies and deformable bodies, as opposed to the traditional separation of statics and dynamics that makes little mention of deformable bodies. In addition, a general vector algebra is developed and vector notation is used freely for those parts of the theory in which such notation seems to be advantageous. • • •

Advances in Geophysics, Vol. 7, edited by H. E. Landsberg and J. Van Mieghem, *Academic Press Inc.*, 111 Fifth Avenue, New York 3, N. Y., 1961, 333 pp., $11.00—The topics surveyed in this volume include controlled experiments on larger scale geophysical problems, atmospheric tides, generalized harmonic analysis, temperature and wind in the lower stratosphere, arctic meteorology and phase relations of some rocks and minerals at high temperatures and high pressures. • • •

Production Data Book by editors of *Precision Metal Molding*, 812 Huron Road, Cleveland 15, Ohio, 1961, 24 pp., $2.00—This year's edition, containing research information on all the precision metal molding processes, has been greatly expanded to include die casting, permanent mold, investment casting, powder metallurgy, and metals extrusion, plus a complete earnings and productivity analysis for both job and captive shops. Statistics from the industries include sales figures, tons of metal parts shipped, production concentration and ten-year trends. Plants are examined by number, size and capacity of machines, number of employees as well as by geographical distribution.

Geology of the Arctic, *University of Toronto Press,* Toronto 5, Ont., Canada, 1961, 2 vols., 1196 pp., $25.50—Constituting the Proceedings of the First International Symposium on Arctic Geology, held January 1960 under the auspices of the Alberta Society of Petroleum Geologists, the two books contain 103 papers on the geology of the "polar mediterranean" by eminent international geological scientists. Volume I is devoted entirely to a study of the regional geology of the area, including the Soviet Arctic, Spitsbergen, Greenland, Canada, Alaska and the Arctic Ocean Basin. Volume II contains papers on glaciology, permafrost, climatology, geomorphology, plus logistics and exploration. With the ever-increasing importance of the Arctic region to the mineral industries, this publication will undoubtedly be an important geologic reference. • • •

Mining Directory of Minnesota, 1961 by Henry H. Wade and Mildred R. Alm, *Mines Experiment Station* University of Minnesota, Minneapolis, 14, Minn., 1961, 288 pp., $1.00—This annual publication of up-to-date information on the iron mining industry of Minnesota is in four parts: maps; pertinent information on all properties that have shipped ore or are listed on the tax records as containing merchantable ore; a list of all the operating and major holding organizations, together with a list of officials, subsidiary and affiliated companies and the properties in which they are listed; and general statistics on the iron ore industry.

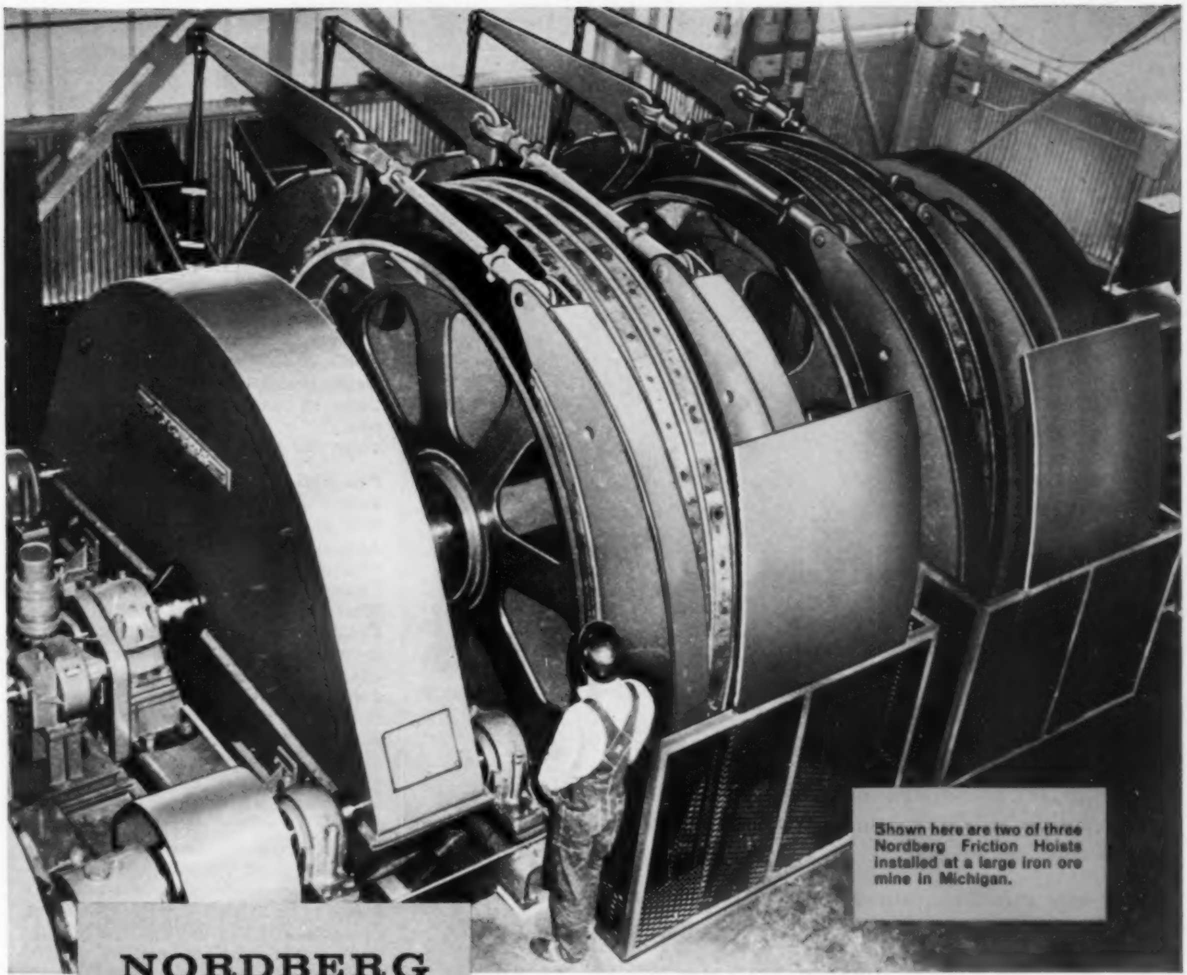
Soviet Power: Energy Resources, Production and Potentials by Jordan A. Hodgkins, *Prentice-Hall Inc.*, 1961, 208 pp., $5.25—This new work is a definitive analysis of Soviet coal, oil, oil shale and natural gas resources—their potentials, production and consumption. It shows specifically what, where and how much the Soviets have quantitatively and qualitatively in natural fuels. Region by region, the exact site of each reserve is pinpointed by field, basin and deposit. Each energy resource is traced from its point of origin to its consumption in various sectors of the Soviet economy. • • •

Engineering Fundamentals for Professional Engineers' Examinations by Lloyd M. Polentz, *McGraw-Hill Book Co. Inc.*, 1961, 366 pp., $9.50—Fundamental engineering principles in mathematics, mechanics, fluid mechanics, thermodynamics, mechanics of materials, electricity and electronics, chemistry and engineering economics are outlined. Each principle is first explained, then applied to specific engineering problems; finally, problems from past examinations are provided for practice and review. (Answers are at the end of the book, but emphasis is on method and presentation of the solution throughout the book, rather than on the answer itself.) • • •

Exploitation des Mines, Vol. I by V. Vidal, *Dunod Editeur,* Paris, France, 1961 714 pp., no price given—This first volume of a projected series on the mining industry of France consists of four main sections: basic economic and organizational aspects of mine development; methods and equipment for cutting, blasting and loading operations; rock mechanics and roof support design; shaft sinking and driving of galleries. The book is extensively illustrated, and both the theoretical and practical aspects of the subjects are thoroughly covered.

Axial Flow Fans by R. A. Wallis, *Academic Press Inc.*, 111 5th Avenue,

(Continued on page 1198)



Shown here are two of three Nordberg Friction Hoists installed at a large iron ore mine in Michigan.

NORDBERG Friction Type MINE HOISTS

. . . used for economical SERVICE and PRODUCTION HOISTING

Where applicable, service or production hoisting can be economically handled with Nordberg Friction Type Mine Hoists . . . built for either counterweighted or in-balance operation, geared or first motion electric drive, manual and/or fully automatic control.

Outstanding features of the Nordberg design include: one-piece welded steel drum; anti-friction roller bearings throughout; a choice of pressure applied—pressure released or gravity applied—pressure released brakes, all with emergency gravity back-up.

In addition to friction types, Nordberg *Drum Hoists* are in wide usage throughout the world; are available with manual, push-button semi-automatic, or fully automatic control.

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BOOKS

(Continued from page 1196)

New York 3, N. Y., 1961, 366 pp., $10.00—The recent advances in general aerodynamics are analysed for the ventilating engineer in a consistant and practicable theory. A simply-followed design method is presented with basic data for application to the problems of design, ducting or analysis likely to arise in relation to ducted axial flow fans. Basic principles and design assumptions of ducts, rotors and stators, analysis of rotors and stators, torque, noise and testing are presented. • • •

Principles of Resource Conservation Policy prepared by Committee on Soil and Water Conservation of the Agricultural Board, *National Academy of Sciences—National Research Council*, 2101 Constitution Avenue, Washington 25, D. C., 1961, 50 pp., $1.50—Two major concepts of conservation are developed in this report: 1) conservation should be defined as measures for the maintenance of productive capacity, including provision of a reserve and of growth to meet future needs and 2) production practices should include all measures which increase the output of products and services from land and water resources at a particular level of productivity. The report is an attempt to formulate a framework which can guide policy development and to provide a factual and logical foundation for sound conservation in the years ahead. Chapters include: *Nature and Objectives of Conservation; An Analytical Framework for Appraising Conservation; Physical, Economic and Institutional Interrelationships in Resource Conservation; Problems in Achieving Soil and Water Conservation;* and *Recommendations for Research, Education and Policy.*

CANADA

Government Publications

Queen's Printer
Ottawa, Ontario

Summary of Developments in the Canadian Mineral Industry 1959, Preliminary Review 1, 1960, gratis.
The Determination of Total Rare Earths in High Grade Uranium Products, Research Report R67, 1960, 25¢.
A Study of Mercury-Cathode Membrane Cells for the Electrolytic Reduction of Uranyl Solutions, Research Report R70, 1960, 25¢.
The System Iron-Titanium-Oxygen at 1200°C and Oxygen Partial Pressures Between 1 ATM. and 2 x 10^{-14} ATM., Research Report R76, 1965, 25¢.
Holmquistite from Barraute, Quebec, and A Zirconium-Bearing Garnet from Oka, Quebec, Technical Bulletin TB7, 1960, 25¢.
Metal and Industrial Mineral Mines in Canada, Operators List 2, 1960, 25¢.
Milling Plants in Canada Metallic Ores, Operators List 3 Part 1, 1960, 25¢.
Milling Plants in Canada Industrial Minerals Operators List 3 Part 2, 1960, 25¢.
Ceramic Plants in Canada, Operators List 6, 1960, 25¢.
Summary Review of Federal Taxation and Legislation Affecting the Canadian Mineral Industry, Mineral Information Bulletin MR 42, 1961, 50¢.

LETTERS

(Continued from page 1188)

provide opportunity for good outdoor recreation. Unfortunately, the 18-hole Catavi course is no longer well kept up and is used only rarely since the enforced departure of Patino Mines & Enterprises. I believe you mentioned John Hoffman had started a layout at San Salvador at over 13,000.

Sincerely,
R. T. Chapman

BOOKS

(Continued from page 1198)

Survey of the Primary Zinc Industry in Canada, 1959, Information Bulletin MR 43, 1960, 50¢.
A Survey of the Uranium Industry in Canada, 1959, Mineral Information Bulletin MR 44, 1960, 50¢.
A Preliminary Survey of the Canadian Mineral Industry in 1960, Mineral Information Bulletin MR 49, 1961, 25¢.
The Platinum Metals, Mineral Report 3, 1960, $1.00.

Ontario

Publications Office
Dept. of Mines
Toronto, Canada

Report on Uranium and Thorium Deposits in the District of Sudbury, accompanied by a set of 10 maps and plans, 1961, gratis.
Pleistocene Geology of the Galt Map-Area, Geological Circular No. 9, accompanied by a geological map, 1961, gratis.
Preliminary Report on Mining Properties in the Township of Bucke, District of Timiskaming, 1960, $2.00.
Preliminary Geological Map of Concession I, Bucke Township, uncolored print, 1960, $1.00.
Preliminary Geological Map of Concession II, Bucke Township, uncolored print, 1960, $1.00.
Map of Underground Workings in the South-eastern Part of Bucke Township and a Profile Across the Lake Timiskaming Fault Zone, 1960, $1.00.
Preliminary Report on Parts of Coleman Township and Gillies Limit to the South and Southwest of Cobalt in the District of Timiskaming, 1960, $1.00. In conjunction with the report, five uncolored preliminary geological maps are available, $4.50 per set. A legend sheet is available for $1.00.
Preliminary Geological Map of the Lac des Mille Lacs Area (west half) in the District of Thunder Bay, 1960, $1.00.
Preliminary Report on Mineral Deposits of the Big Duck Lake Area in the District of Thunder Bay (P.R. 1961-1), $1.00. In conjunction with the report a preliminary geological map of the same area, revised January 1961, is available, 50¢.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Productivity in the Lead-Zinc Industry by *H. M. Callaway*—The author presents an analysis of the trends in productivity in the lead-zinc industry. The author attempts to define "productivity" in view of the problem of discontinuous indices and non-uniform information. Going beyond the standard units affecting productivity (time units, number of employees, quantity of output) the author lists other factors that should be accounted in such an expanded productivity expression including grade of ore, capital investment, power equipment and supplies, technology, management skill and market value of product. **Ref.** (MINING ENGINEERING, **November 1961) p. 1222.**

Programming the U.S. Bureau of Mines' Multi-million-Dollar Minerals Research by *C. W. Merrill*—The author describes the organizational pattern established within the U.S. Bureau of Mines to facilitate the operation of its research departments. The development of research programs from conception to final authorization consists of studies of all mineral commodities balanced with the importance of each mineral to national defense, standard of living and population growth. The final project authorized by the federal government reflects the views of various men and committees as to the value of each proposed commodity research project in line with the aforementioned mission of the Bureau. The author briefly discusses the manner in which each research project authorized is controlled at the assigned research center. **Ref.** (MINING ENGINEERING, **November 1961) p. 1226.**

Cinnabar at Cordero by *Elwin L. Fisk*—Located in northern Nevada, Cordero mine produces mercury ore from numerous minor fractures and faults along one boundary fault of a graben. The host rock in this area is a series of rhyolites topped by a silicified rhyolite called "opalite." The main orebody is confined along a major fault but numerous small lenses are found on either side of the orebody. **Ref.** (MINING ENGINEERING, **November 1961) p. 1228.**

Tailing Pond Design by *Frank Windolph*—The new tailing deposit area at Climax mine is described. The earthen toe dam which impounds the initial tailing is a key to stability at the tailing dam. Construction of the dam is aptly described with additional information supplied on decanter lines and decanting towers as well as a description of the tailing materials. **Ref.** (MINING ENGINEERING, **November 1961) p. 1231.**

The Esperanza Concentrator by *C. H. Curtis*—This article contains a comprehensive survey of the Esperanza concentrator southwest of Tucson, Ariz. The author supplies details of the crushing, wet grinding, and flotation of the copper ore plus information on water supply and molybdenum recovery. Three detailed flowsheets are provided. **Ref.** (MINING ENGINEERING, **November 1961) p. 1234.**

Design of Concrete Headframes for South African Gold Mines by *A. C. Backeberg*—This article is part of a report by the author presented at the 7th Commonwealth Mining and Metallurgical Congress in South Africa. The author describes the controlling factors influencing the design of reinforced concrete headframes. Construction of the Margaret and Riebeeck shafts are cited as examples. **Ref.** (MINING ENGINEERING, **November 1961) p. 1240.**

Geologic Studies Play Major Role at Hudson Cement Co.'s Quarry by *J. R. Dunn*—Much of the success enjoyed by the Hudson Cement Co. can be attributed to detailed geologic work. In this area of the Hudson Valley the great structural complexity of the rocks plus the multiple uses for the stone dictated the use of such studies. They have paid dividends in long and short range planning, in assessment of reserves, reduced costs of chemical analyses and reduced drilling costs. **Ref.** (MINING ENGINEERING, **November 1961) p. 1243.**

Permeability and Compressibility Tests Aid in Selecting Suitable Hydraulic Fill Materials by *D. F. Mickle* and *H. L. Hartman*—The authors discuss the effect of permeability, particle size, stratified fractions and compressibility on hydraulic fill materials that are available for use in the anthracite region of Pennsylvania. The material included coal washes or ash and alluvial sand from the area. It was concluded that the permeability of this material was suitable for hydraulic fill. The permeability and compressibility studies reported here have laid the groundwork for a quantitative and comprehensive approach to the problems of hydraulic filling. **Ref.** (MINING ENGINEERING, **November 1961) p. 1246.**

expensive and time-consuming secondary blasting.

2. Ripping is safer than blasting. And in many cases this can mean lower liability insurance rates.

3. A ripping tractor offers the extra dividend of availability for various bulldozing jobs when it has completed its ripping assignments.

All told, the savings can be quite considerable. In fact, it is a rule of thumb that a ripping tractor used on a production basis can loosen ore and overburden for one-third to one-half the cost of drilling and blasting. In many cases, savings even top that. For example, on the Mesabi Range rock was ripped with D9s for *10% of the cost of drilling and blasting.*

The chart below gives some examples of typical savings. All are actual cases where Caterpillar track-type Tractors with rippers replaced drilling and blasting.

LOCATION	MATERIAL	Ripping Costs (Cents/Cu. Yd.)	Drilling and Blasting Costs (Cents/Cu. Yd.)
Tulsa, Oklahoma	Limestone	7.3	17.3
Dallas, Texas	Limestone	5.2	15.1
San Francisco, Calif.	Sandstone	15.0	30.0
Merriam, Kansas	Sandstone	2.1	11.7
Nelsonville, Ohio	Sandstone	5.7	13.8
Philadelphia, Pa.	Limestone	11.5	19.3
Carbo, Virginia	Sandstone	8.6	15.7
Hibbing, Minn.	Frost	25.0	60.0
Hibbing, Minn.	Paint Rock	6.1	54.5

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21	22	23	24	25	26	27	28	29	30
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41	42	43	44	45	46	47	48	49	50
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81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110
111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150

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91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110
111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150

Name .... Title ....

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City and Zone .... State ....

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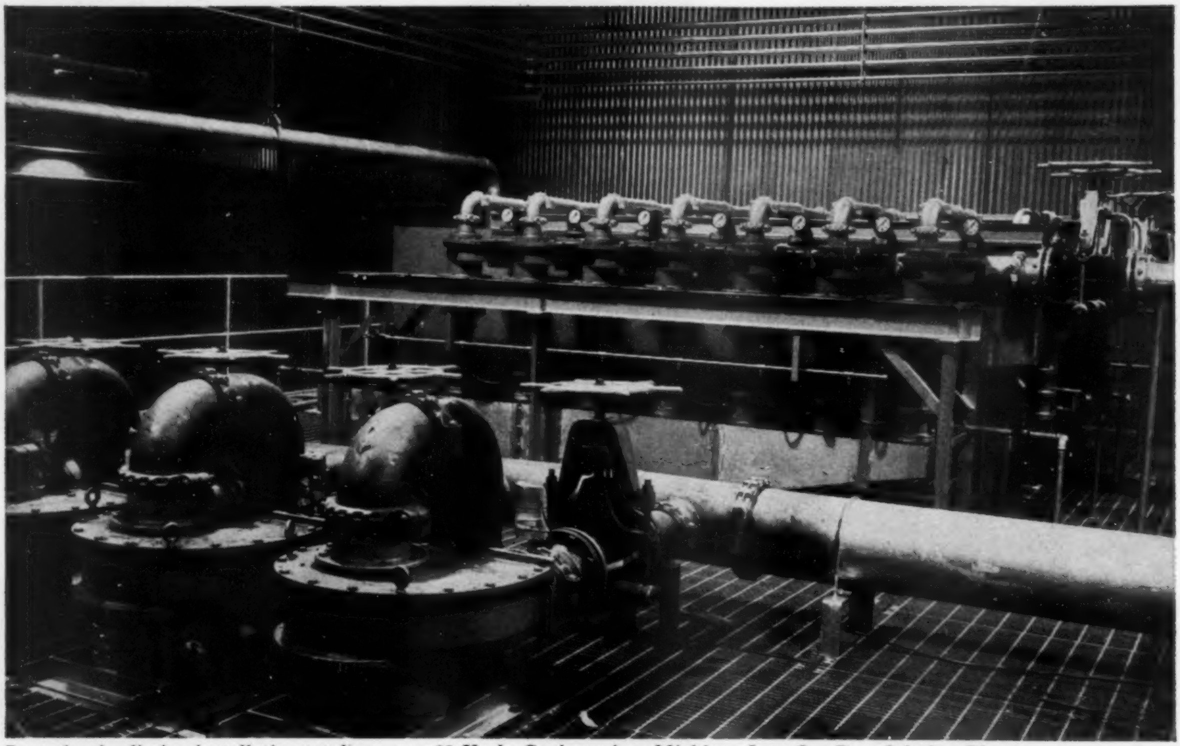


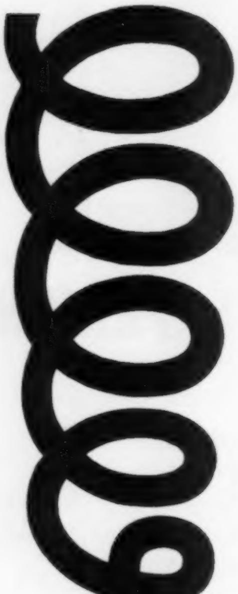
Part of a de-sliming installation totaling some 60 Krebs Cyclones in a Michigan Iron Ore Beneficiation Plant.

Why Krebs Cyclones give you Better Classification, yet cost less

Greater capacity per unit size Because the involuted feed entry on a Krebs Cyclone minimizes turbulence and pre-orients particles for efficient classification, a larger vortex finder can be used for a given size cyclone, providing higher capacity and equivalent separation for a given pressure drop. This same design feature can be used advantageously to obtain a finer separation for any equivalent cyclone, orifice combination and pressure drop.

Greater flexibility Because Krebs Cyclones are available with the widest variation in orifice sizes, including adjustable apex valves, they can be tailored more carefully to fit the precise requirements of a given job. As a result, Krebs Cyclones not only match capacity requirements with the highest degree of accuracy, but also provide the optimum in fineness and sharpness of separation.

Greater life expectancy Because Krebs Cyclones utilize specially compounded, extra-high-density liners, they exhibit extremely good abrasion resistance and outlast vulcanized or low-pressure molded liners many times over. Many main body liners in Krebs Cyclones have been in service for more than 5 years, some having handled in excess of 2 million tons per unit.



Because Equipment Engineers Inc. is devoted exclusively to cyclone technology, you get all the advantages of dealing with a specialist when you specify Krebs Cyclones. Your classification problems are studied by a staff of skilled engineers representing an unmatched accumulation of experience in the design and practical application of cyclones in the metallurgical field.

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NEWS

FROM MINE AND MILL

HERCULES POWDER RETIRES "THE EXPLOSIVES ENGINEER"

"The Explosives Engineer" magazine which served the explosives-consuming industries will terminate its activities with the publication of the November-December issue. Published periodically by Hercules Powder Co. since 1923, the magazine has long been considered the industry's "unofficial bible" by users of explosives.

Montgomery R. Budd, Hercules' director of advertising, said, "Today, thanks to the maturity of the industrial press, there is competent and adequate, yes, even brilliant coverage of those segments of industry previously considered the editorial sphere of The Explosives Engineer. It is reluctantly, and with great regret, that we announce the termination of the magazine which has fostered the present day scientific use of commercial explosives."

The National Safety Competition, sponsored since 1925 by the magazine and the Bureau of Mines, will hereafter be conducted entirely by the Bureau. The six bronze "Sentinel of Safety" trophies, whose custody is awarded annually to operations achieving the best safety records in six categories, have been given to the Bureau without cost or restriction by Hercules, along with the well known green and white safety flags and similar items connected with the competition.

SILVER PRICE DESTINED TO RISE?

A recent issue of *Business Week* magazine reported that an increase in the price of silver is imminent. Demand for the product has far outweighed production over the past decade, thus outdating the Treasury's current buying price of 90.5¢ per oz.

Simon D. Strauss, Vice President of American Smelting & Refining Co., says the price likely will climb to about $1.10 per oz, which should eventually stimulate exploration and new production of silver. He does not think the higher price will drive any significant number of consumers to substitute materials.

Silver producers have been complaining that the Treasury's sale of silver has been keeping the price artificially low. The Treasury insists it is only following the law which permits it to buy all domestically mined silver offered at 90.5¢—and sell a bit higher.

Producers argue that if the Treasury would cease selling, it would stimulate production. Robert M. Hardy, Jr., president of Sunshine Mining Co., says the "Treasury cannot indefinitely hold the price down. The only thing to close the gap is new production." He adds that this will only come with higher prices.

LEAD-ZINC INDUSTRY RECEIVES SUBSIDY

President Kennedy recently signed a bill authorizing a four-year, $16,500,000 stabilization program to aid small lead and zinc producers. A "small" producer is considered one which has not sold more than 3000 tons of lead and zinc combined in any single year since Jan. 1, 1956.

The bill provides subsidies of 75% of the difference between 14.5¢ per lb and the market price of lead. It provides a payment of 55% of the difference between 14.5¢ per lb and the market price of zinc. Producers will become eligible in January.

BETHLEHEM DEDICATES RESEARCH LABORATORIES

Bethlehem Steel Co. recently held formal dedication ceremonies at its new $25 million Homer Research Laboratories in Bethlehem, Pa. This event marks the geographical consolidation of the company's research activities.

In these laboratories, the research staff (450 employees) will tackle projects ranging from the study of involved chemical reactions to practical investigations of the construction of better refractory linings.

In the dedication address, Arthur B. Homer, the company's chairman and chief executive officer, announced that one of the main goals of future research will be to develop a process which would combine steel's already achieved qualities of strength and durability with the presently difficult virtue—low cost.

Mr. Homer also expressed interest in a research activity dealing with a "special new alloy steel which shows great promise in meeting the tremendous high-strength requirements of space vehicles."

Some other achievements which Mr. Homer hopefully foresees are:

1) Structural steels which could possibly develop into a whole new family of steels.

2) High-strength steels for tonnage products such as shapes and plates.

3) New kinds of coated or alloyed steels able to resist a wide range of corrosive conditions.

4) Processes by which metals like chromium, titanium, aluminum and others are actually diffused into the surface layers of sheet steel.

5) Methods to combine plastic compounds and steel.

The **picture above** shows the Homer Laboratories site on South Mountain in Bethlehem. Major structures in the research complex are the U-shaped (with wing extensions) Administration and Laboratory Building; saw-tooth, ridge-roofed Shops and Warehouse Building; three-fingered Pilot Plant Building (Process Metallurgy wing completed, Electro-Mechanical and Mechanical Engineering wings still under construction); Central Heating and Refrigeration Building; Photography Building; and 210-ft diam cooling pond for the air conditioning system.

INDIA GRANTED LOAN BY WORLD BANK

The World Bank has made a loan equivalent to $35 million to India to help increase production of the private coal mining industry. To meet the industrial goals of the Third Five-Year Plan, India's annual production of coal will need to be increased by some 80% above present output—from 54.6 million to 97 million tons in 1966, the last year of the Plan period. Private companies intend to expand existing facilities and open new mines to increase annual production of coal from 44 million to 61 million tons. Total cost of the program to be carried out by private industry during the Plan is estimated at the equivalent of $116 million.

Four private banks are participating in the loan—without World Bank guarantee—to the extent of $875,000, representing portions of the first maturity which falls due in May 1966. The loan is for a term of 15 years and bears interest at the rate of 5¾% per annum, including the 1% commission which is allocated to the Bank's Special Reserve.

CHILE'S COPPER STRIKES CAUSE PRODUCTION SLUMP

Provisional figures released by the Chilean Copper Department show that copper production by U.S.-owned mining companies there dropped by 75% during August. Output for the month was 10,909 tons as compared to 43,062 tons in July. The decline was due to the work stoppages which started August 11 and ended September 11 after a 60-day truce was established in order to permit negotiations for new contracts to be resumed.

CHILE RAISES TAXES ON COPPER PRODUCTION

U.S. copper interests in Chile received another blow recently when the government's House of Deputies passed a bill increasing taxes. The increase is designed to provide funds for an increase of 16% for workers' salaries.

Robert Haldeman, Vice President of Braden Copper Co. which has properties in Chile, pointed out that approval of this bill means the company will have to pay 82% tax on its net profits plus an additional 8% next year. This tax, together with others in force and still other proposed taxes, the company expects to have to pay Chile's government a total of $46.2 million.

M. A. HANNA CO. PLANS REORGANIZATION

Directors of The M.A. Hanna Co. have approved a plan of simplification of the ownership and management of the company's various business interests. Under the plan, to be voted on at a stockholders' meeting October 31, the company proposes to dispose of its direct business activities and become a closed-end investment company, with assets of approximately $500,000,000 of value, largely consisting of common stocks and cash items.

Approximately 70% of the company's assets will be concentrated in the stocks of three companies: National Steel Corp., Consolidation Coal Co. and The Hanna Mining Co.

M. A. Hanna's principal direct business activities have formerly been the management and operation of mining, shipping and dock operations of its affiliated companies. Under the proposed plan, these will be sold to Hanna Mining, which will also acquire the M. A. Hanna interest in Iron Ore Co. of Canada, under terms of that company's charter.

The company's lake coal and vessel fueling business will be sold to Consolidation Coal. The Empire-Hanna Coal Division in Canada will be sold to outside interests except for a vessel fueling dock at Windsor, Ontario. The anthracite business will be sold to a new and independent group.

BETHLEHEM DEVELOPS PRESINTERING PROCESS

Millions of tons of previously unusable ores found in the Lake Superior region and in foreign fields are now available for blast furnace processing by Bethlehem Steel Co. through a newly patented method of preparing wet iron ores for sintering.

This method enables certain wet iron ores containing as much as 15% of water to be economically used in steelmaking. This is accomplished by mixing the wet ore with a proper amount of dry flue dust, coke or sinter particles to dry the ore to a water content of no more than 7½%.

Before treatment, the ores are difficult to screen because of their gummy consistency. Reducing the water content results in a mealy mixture which may then be passed over the sintering screens. Particles larger than 3/16 in. go directly to the blast furnace, while the smaller particles are formed into pellets and sintered with fine coal or coke dust.

1975 U.S. COAL DEMAND TO REACH 670 MILLION TONS

Demand for coal in the U.S. should reach 670 million tons a year by 1975, according to T. Reed Scollon, Chief of the Bureau of Mines' Division of Bituminous Coal. In 1960, the Nation produced approximately 434 million tons of coal.

In a recent address at the Southern Research Institute, Birmingham, Mr. Scollon noted that while the coal industry must contend with serious problems for sometime, it also can expect larger markets as the Nation's needs expand.

Most of the coming increase in coal demand will result from projected expansion of electric-power generation, according to Scollon. Coal is expected to provide the largest share of energy required in achieving an annual output of 1772 billion kw-hr of electricity, which is the estimate recently adopted by the Federal Power Commission for 1975. The amount of coal used for power generation alone in 1975 may thus exceed last year's total production.

PNEUMATIC BULK HANDLING EMPLOYED IN KENYA

At the joint CIM-AIME Industrial Minerals Conference in Ottawa last month, MINING ENGINEERING learned that pneumatic handling of bulk cargoes in ocean-going vessels was being employed in Mombasa, Kenya.

Southern Line Ltd.'s *Southern Baobab* recently shipped 2400 tons of Mombasa cement to Dar es Salaam, Tanganyika's capital. The ship is equipped entirely with pneumatic loading and unloading machinery. When the machinery reaches its peak of perfection, it should be able to load a complete cement cargo in about eight hours—an extraordinary improvement over the manual method which took approximately three days.

IMC RECEIVES LOAN FOR EXPANSION

International Minerals & Chemical Corp. has negotiated a $40 million loan with The Prudential Insurance Co. of America for a 20-year term. A part of the capital will be allocated to the Saskatchewan potash mine and plant of IMC's Canadian subsidiary which is scheduled for production next summer at an annual capacity of 420,000 tons. A current $10 million expansion program is expected to boost that output to 1,200,000 tons by early 1963.

Other capital expansion plans include $3.2 million for a diammonium phosphate plant under construction in Florida, $4 million for an expansion and cost reduction program in the phosphate mining and processing facilities there, and $1 million to launch a new fermentation process for manufacturing "Ac'cent," a product for enhancing food flavor. Funds from the loan will also be used to retire a $10 million revolving credit loan and to refund $5.5 million in notes due July 1, 1964.

WESTERN MINERAL ASSOC. UNITES WITH CHEMICAL CO.

Western Mineral Associates of San Francisco recently announced its affiliation with Associated Chemicals of Pomona, Calif. In a statement to MINING ENGINEERING, Robert M. Dreyer, President of WMA, indicated that the new association is designed to pool company resources for "the exploration, production and utilization of mineral raw materials for the chemical industry." The joint venture will provide mining, geological, geophysical and chemical process engineering services to its clients.

HANNA MINING CO. EXPANDS FACILITIES

The Hanna Mining Co. has announced that it will increase the annual capacity of its Groveland iron ore concentrating plant in Michigan from 700,000 tons to 1,500,000 tons and will install facilities to produce 1,250,000 tons of high grade, partially fluxed iron ore pellets a year. The expansion program will commence in the near future and will be completed by 1963. Groveland, located on the Menominee Range near Iron Mountain, produces high grade iron ore concentrates from jasper.

TWO FIRMS FORM POTASH PARTNERSHIP

Kerr-McGee Oil Industries, Inc., and National Farmers Union Service Corp. are forming a new company to mine and mill extensive potash reserves near Carlsbad, N.M. The new enterprise, Kermac Potash Co., will be a partnership in which a wholly owned subsidiary of each parent company will have a 50% interest.

A large-scale pilot plant program is being launched immediately at Kerr-McGee's metallurgical research laboratory at Golden, Colo., to finalize engineering design plans and specifications for a 1500-tpd potash plant on which construction is to be started at the earliest possible date. Kerr-McGee will be operating partner for all phases of the new venture.

SENATOR GETS REVERSAL ON URANIUM RULING

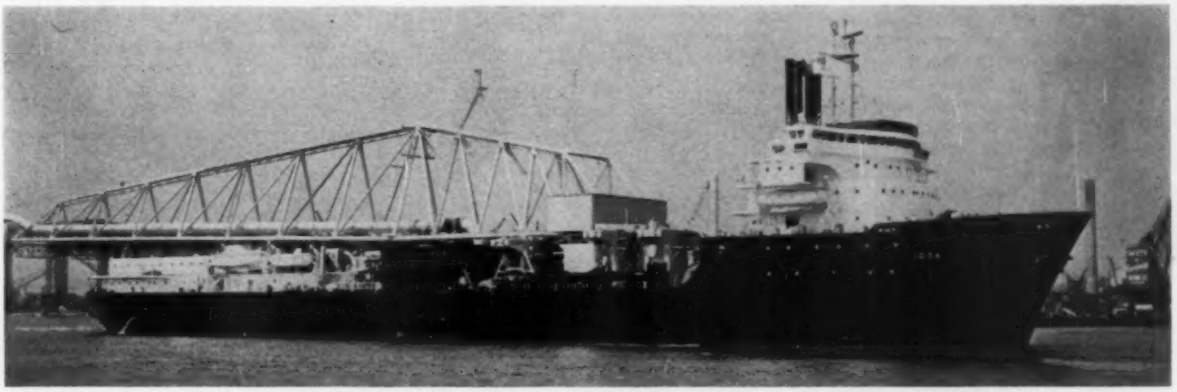
Sen. Wallace F. Bennett (R-Utah) has made public a letter from Assistant Secretary of the Treasury Stanley S. Surrey, clarifying the position of the Treasury Department on depletion regulations concerning uranium and crushed stone.

The Treasury Department previously had announced that crushing and grinding operations would no longer be considered "mining" activities for depletion purposes, and that the ruling would be applied retroactively (for the years prior to 1961). Senator Bennett, during Finance Committee questioning of Secretary Surrey, succeeded in getting an agreement to reverse the retroactive provision of the ruling.

IOCC TO BUILD PELLETIZING PLANT

The Iron Ore Co. of Canada is planning construction of a pelletizing plant for its Carol Lake iron ore project which is scheduled for production by next year. The plant, estimated to cost about $60 million, will be located near the Carol Lake 50,000-tpd concentrator.

The property, located on the Labrador side of the Quebec-Labrador Trough, is the second major development in that area by the company. (See MINING ENGINEERING, June 1961, pp. 595-597 for more information on the Carol Lake project.)



NEW DREDGE MAINTAINS VENEZUELA CHANNEL

"Icoa" is the name of a legendary Indian princess of the Orinoco area near Caracas, Venezuela; this appellation is now borne by a 16,500-ton dredge which was recently commissioned to maintain the 24 ft wide, 180-mile channel from Puerto Ordaz to the Caribbean Sea via the Boca Grande Channel along the Orinoco.

The new dredge was built by National Bulk Carriers in Kure, Japan for the Orinoco Mining Co. and will be operated by the builders for one year, at which time it will be officially turned over to the mining company. Putting the dredge into operation will cost Orinoco about $54 million.

The ship achieves a total of 32,180 hp in Nordberg diesel engines. Propulsion is supplied by two 2-cycle superthermal engines, each providing 5250 bhp at 255 rpm. Each of four 2-cycle superthermal pumping diesels supplies 3420 bhp at 230 rpm. The motor generator sets are driven by four 4-cycle superthermal engines, each putting out 2000 bhp at 514 rpm.

The 372-ft boom **(at right)** can discharge 29,200 gal of spoil per minute.

Waste can also be discharged from hoppers, i.e. carrying it aboard and dumping it elsewhere.

It is interesting to note that only ten years ago it was considered impossible to dredge the Boca Grande because of the presence of littoral cements. Later studies revealed, however, that the cements were not littoral but fluvial in direction—thus, the job of the "Indian princess" was made possible.

New Series 100 Hammerdril

chip size proves Hammerdril puts more *bite* in your bit because it cleans as it drills

When it comes to chips, think big. Big chips are a sure sign of economical drilling action, the kind that saves air, speeds drilling rate. With the Series 100 Hammerdril® air either drills or cleans. You can start at once with this dependable bottom hole pneumatic impact tool on your present rig and 100 psi compressor. Simply adjust the Hammerdril with the proper positive choke to suit your compressor. Then dig in, using the Mission Hammerbit®. The heavy tungsten-carbide inserts can be dressed in the field.

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Circle No. 21 on the reader service card.

Pneumatic Sledge Hammer

The Branford Co. has introduced their Vibrajust pneumatic sledge hammer with manual control of impact frequency and full range of impact control. The low air consumption of the manifold-controlled hammer (less than 20 cu in. per blow) provides applications where amount of air consumed is a major consideration. It can be attached to a bin, chute, truck body, conveyor or any materials handling equipment that requires occasional blows to keep material flowing. The f.o.b. factory price is $325. **Circle No. 76.**

Variable Aperture Stop

AGA Corp. of America has developed the increased daylight range for Models 4A and 4B Geodimeters. Distances are measured by projecting a modulated light beam from the Geodimeter to a distant reflector. Light is reflected back to the unit where a phase comparison is made by special electronic techniques between the modulated projected light and the light being received. Inserted is an aperture opening of 0.5 mm which gives a vision area of about 2-ft diam at a distance of 2000 ft. This instrument is used for measuring base lines, traverse sightings, offshore hydrography, oil and mine surveys. Installed price of the aperture stop is $85.00. **Circle No. 77.**

Continuous Mixers

A new line of continuous mixers is now available from *Falls Industries, Inc.* Fourteen standardized sizes are available in single and double shaft models to provide a wide range of selection; custom units can also be designed to meet precisely the intended application. The mixers can

handle virtually any mix from basic iron ore treatment to fine chemical powder processing at continuous capacities from 150 lb per hr to 100 tph. They can be furnished in carbon steel, stainless, aluminum and alloys. Among design features are paddle contours and adjustable pitch paddles. **Circle No. 78.**

PRODUCTS FOR MINE AND MILL

Hopper Car Vibrator

A portable, self-contained, gasoline-operated hopper car vibrator that develops a force sufficient to unload an entire car from one location without manual assistance, has been announced by the *Martin Engineering Co.* At 3000 rpm, the CCVG-3000

"Big Shake" produces an unbalance force of 6600 lbs, capable of moving such materials as wet sand, rock phosphate, cement, gravel, coal, ore, etc. A built-in mounting clamp feature insures secure attachment to any rigid angle. The 77-lb unit mounts easily and quickly on open or covered cars without the use of cumbersome, expensive auxiliary equipment. **Circle No. 79.**

Ripper Tips and Shanks

Availability of improved design tips and shanks for their No. 8 and No. 9 tractor-mounted rippers has been announced by *Caterpillar Tractor Co.* The tips are of two configurations, one for high impact applications, the other for use in highly abrasive material. The new design "Speed Shank" incorporates a slotted key design for mating tips to shanks. A shoulder on top of the tip butts against a similar surface on the leading edge of the shank, transferring ripping loads to the shank rather than to the tip wrapper and retaining pin. **Circle No. 80.**

Vibrator Clamp

The Cleveland Vibrator Co. has developed a "bolt-bite" clamp that mounts the 3-in. LSF-VG portable air vibrator on small or narrow areas of bins, trucks or railroad cars. Two ¾-in. clamping bolts pass through the top of the cast steel jaw for greater pressure on a smaller area than possible with other clamping devices. **Circle No. 81.**

Hydraulic Trouble Spotter

A compact (5x6x8-in.), portable instrument that can quickly pinpoint hydraulic system problems has been developed by *Schroider Brothers Corp.* Flow gauge of the instrument has two scale ranges: 0 to 10 gpm, and 6 to 30 gpm, with the scales calibrated for easy reading in both low and high gpm ranges. The pressure gauge indicates loads up to 3000 psi, and the temperature gauge records from 20°F to 240°F. Hydraulic troubles are indicated when the rate of flow shows a decline on the flow gauge as working pressure is developed with the load valve. Trouble is then isolated to the pump valve or cylinder by taking flow, pressure and temperature readings on various sections of the cricuit. A plexiglass cover protects gauges from external damage, and the steel load valve stem and hand wheel serves as a carrying handle. **Circle No. 82.**

Roof Pinner

A hydraulically rotated roof pinner (D73RR), designed to drill the hole, insert the roof bolt and tighten the bolt to the required torque, has been introduced by *Gardner-Denver Co.* This hydraulic/pneumatic roof pinner drill incorporates an independent hydraulic rotation motor, has its own

pneumatic feed motor to feed the drill steel into the hole while drilling, plus a pneumatic centralizer for maintaining proper steel alignment. The drill features remote control, adjustable feed mounting and a hydraulic motor of sufficient power for tightening roof bolts to safe torque levels. **Circle No. 83.**

DATA

FOR MINE AND MILL

SOVIET METAL TECHNOLOGY: Diverse phases of Soviet metal technology are outlined in an Index to translations currently available from *Primary Sources*, a New York publishing firm. Included are over 300 titles from 10 Russian technical journals. The booklet also incorporates the complete tables of contents for "Tsvetnye Metally" ("Non-Ferrous Metals"), January through December 1960. The Index may be obtained without cost by writing on company letterhead to, Mr. I. Flohr, Primary Sources, 11 Bleecker St., New York 12, N.Y.

(101) STEEL BELT CONVEYORS: *Sandvik Steel, Inc.* has issued a 16-page booklet on steel belt conveyors entitled, "Pictures of Conveyors in Action." The brochure contains sections on bulk conveying, piece goods conveying, work tables and water bed conveyors. It tabularizes available belt sizes and includes a detailed line drawing of a typical installation. The section on bulk material handling has 12 photos showing conveyors handling such materials as sugar, iron ore and clay. Photos and line drawings show steel belt conveyors as they ride on a bed of water to cool-in-transit such materials as metasilicate of soda, maleic anhydride, pitch and aluminum sulphate.

(102) WIRE ROPE CONVEYING SYSTEMS: A 24-page bulletin describing wire rope conveyors for above and below ground applications is offered by *Hewitt-Robins*. Included in the publication are the advantages and features of the company's wire rope conveyors, basic types of head sections, electricals, power units, idlers, wire rope supports, belt take-ups, tail ends, auxiliary equipment and newly developed components such as hydraulic tensioning units, belt winders, flexible idler stands and utility tractors.

(103) MAGNETIC SEPARATORS: Illustrated Bulletin 993 by *The Jeffrey Manufacturing Co.* describes the new magnetic separators with ceramic permanent magnets. These wet drum separators supplement the company's electro and alnico permanent magnetic machines. Extensive research and development showed wide application of the ceramic magnet-type separators. A higher intensity, deeper and more uniform magnetic field is reportedly developed at less cost than possible with other types of permanent magnets.

(104) ROTARY VALVE: Rotary valves for feeding dry bulk materials, or for use as an air seal, are described in a four-page bulletin released by *The Day Co.* The brochure details construction features of Type A and Type B valves. Also included in the bulletin are application photographs, specifications, dimension charts and diagrams.

(105) VARIABLE-SPEED BELTS: Bulletin 24103, including 14 pages of information for those seeking replacement variable-speed belts, is being offered by *T. B. Wood's Sons Co.* The first table of the bulletin lists all known manufacturers of equipment using variable-speed belts. The manufacturer's variable-speed belt part number is given with Wood's comparable number. The second table gives belt numbers of various equipment manufacturers and the corresponding Wood's belt number. The third table catalogues belts according to size using the new standardized numbering system, which conveys width of sheave groove in sixteenths, groove angle in degrees and belt pitch length in inches and tenths. The fourth table compares Wood's numbers with those of belt manufacturers not using the standardizing system. The old and new Wood's numbers are compared in the fifth table.

(106) EMERGENCY LIGHTING UNITS: An illustrated technical handbook on their line of automatic battery-powered Lightguard emergency lighting equipment has been published by *Exide Industrial Marketing Division* of *The Electric Storage Battery Co.* The eight-page handbook offers complete technical descriptions of the equipment including batteries, chargers, relays, connections, lamps and instrumentation lights and switches of the large range of Exide Lightguard models A, M, T and E. All models provide emergency lighting automatically and instantaneously when normal electrical power fails.

(107) CONTINUOUS BORER AND SHUTTLE CAR: *Goodman Manufacturing Co.* has issued two data sheets covering their 428 continous borer and the 1070 shuttle car. The borer is a single-pass machine for full face continous mining at heights from 6 to 7½ ft. The shuttle car can carry 10 tons at 5 mph and empty at high or low speed from an adjustable discharge conveyor.

(108) FIRST AID EQUIPMENT: Specially designed for training and contest work, a 58-piece first aid outfit is described and illustrated in a folder available from *Mine Safety Appliances Co.* The outfit contains all equipment recommended by the U.S. Bureau of Mines for first aid training, and contest and emergency use. Packaged in a 92x14x13-in. steel case, the contest outfit can be transported easily without loss of materials. Also highlighted in the bulletin are the firm's Jenkins and standard stretchers, bandages, wood splints, emergency first aid outfit for mechanical mining, industrial and miners' first aid cabinets, Type D all-weather first aid kit and pocket first aid packets.

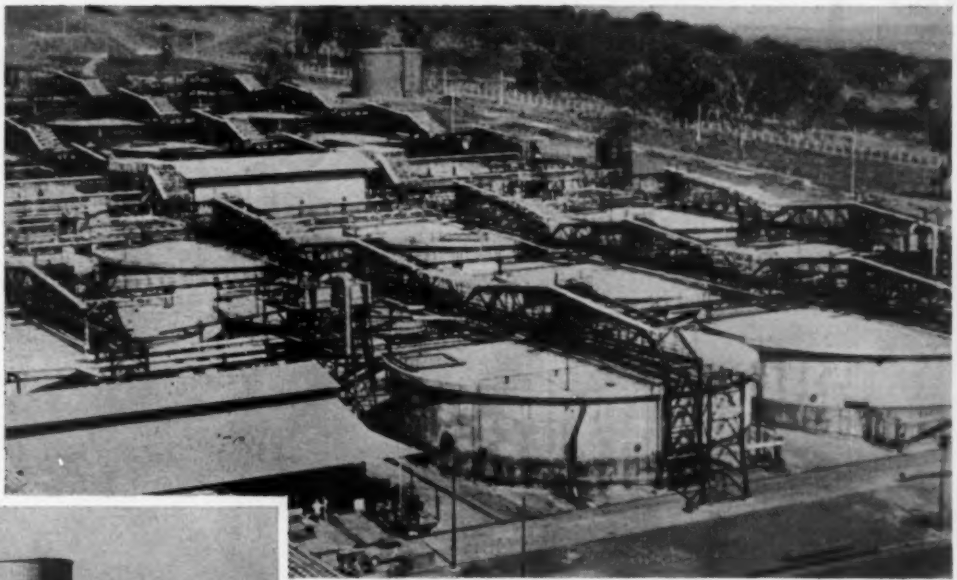
(109) MATERIALS HANDLING: A brochure presenting its full line of materials handling systems, components, special products and services has been issued by *Webster Manufacturing, Inc.* The brochure describes systems of unloading, feeding operations, conveying and elevating, parts and package handling, processing and special conveying for handling bulk materials. Applications for the equipment are in such industries as mining, sand, gravel, chemical and steel.

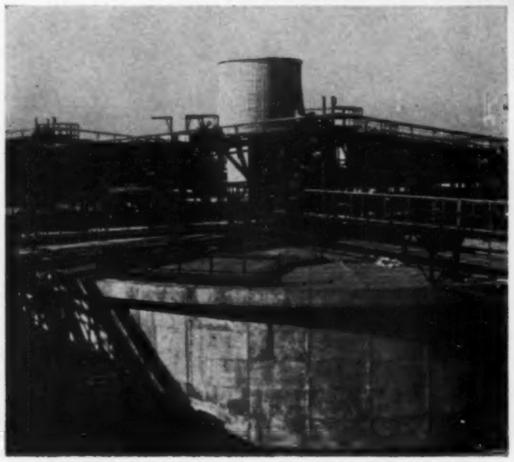
(110) GEAR TRANSMISSION: Bulletin ADH 76, describing the spiroid gear transmission in Porta-Hoist, has been offered by *Coffing Hoist Division* of *Duff-Norton Co.* The brochure includes specifications and dimensions for the aluminum Porta-Hoist line as well as other portable hand chain hoists and I-beam trolleys. Accessories for all models are also described.

(111) CLASSIFICATION AND DEWATERING PLANTS: *COMCO Corp.* has released a six-page bulletin (R-100) describing the operation and performance of a new compact classification plant that operates automatically, without operators and without power (except for pumps). Flow diagrams, accuracy curves and engineering descriptions are given, and dewatering components are described.

(112) SPLIT-CASE CENTRIFUGAL PUMPS: An eight-page bulletin (105C) describes the complete line of single-stage, double-suction, horizontal split-case pumps manufactured by the *Aurora Pump Division, The New York Air Brake Co.* It also contains sectional photos, selection charts, dimensional data, limitations chart and enginering and architectural specifications. Features include: suction and discharge connections in bottom half of case, removal of rotating element without disturbing piping, short bearing centers, scientifically balanced impellers keyed and screw-locked in position and pressure-seated bronze case wearing rings. Capacities range up to 6000 gpm, heads to 380 ft.

28 EIMCO-PROCESS Thickeners at FRIA





Eimco-Process lifting devices on the 100-ft. diameter thickeners at FRIA permit raising or lowering the entire mechanism 3-ft with no relative movement between shaft and main gear. Operator always has positive control of mechanism position. Mechanisms are double extra heavy duty type. Write Eimco's Process Engineers Division, 420 Peninsular Ave., San Mateo, California, U.S.A. for Bulletin SM-1004.

THICKEN AND WASH DIFFICULT RED MUD

FRIA, an organization owned by Pechiney, France, Olin, U.S.A., and several other European aluminum companies, operates one of the world's largest alumina plants in West Africa.

The huge plant employs 26 Eimco-Process 100-ft. diameter covered thickeners in the red mud washing circuit and two 60-ft diameter tray thickeners for lime mud thickening.

In developing the many special design features for these thickeners, FRIA and Eimco-Process engineers worked as a team; were guided by previous experience in engineering equipment for difficult scaling conditions and extremely high torque requirements. Two identical 100-ft. diameter Eimco-Process thickeners were supplied for the Pechiney alumina plant at Gardanne, France, before FRIA went into operation.

In this same way, Eimco-Process specialists are organized to work with your engineers, to help you get effective solutions to your problems. For details, get in touch with the Eimco-Process representative in your area.

EIMCO

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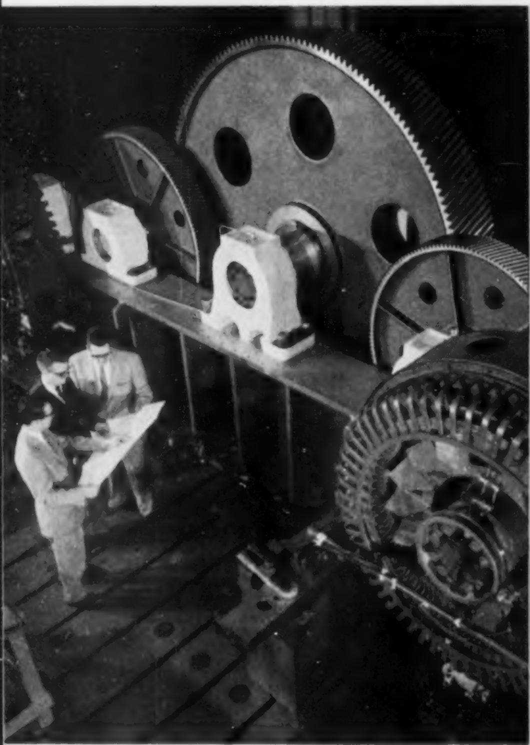

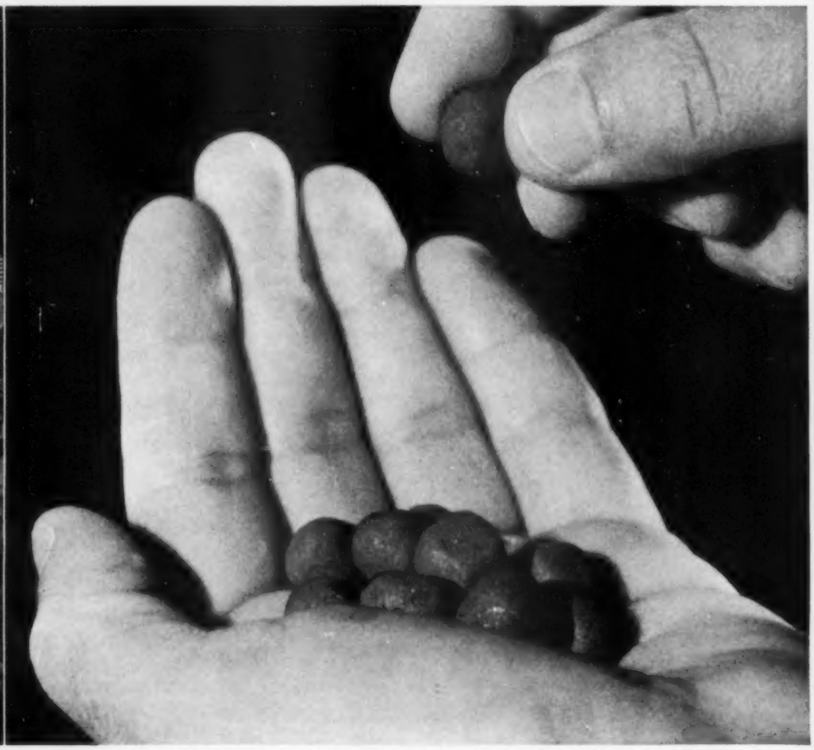

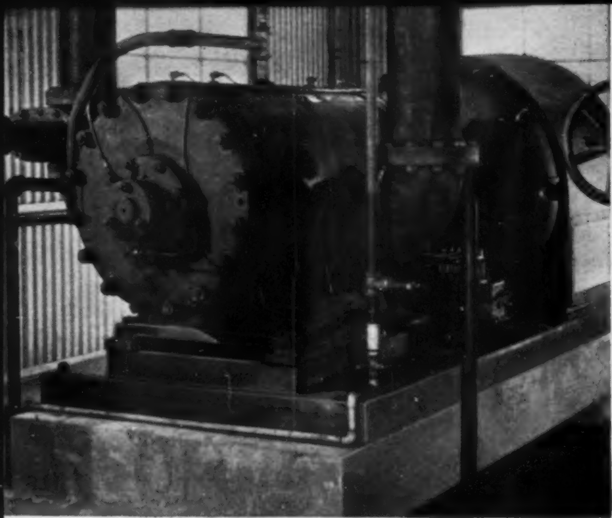

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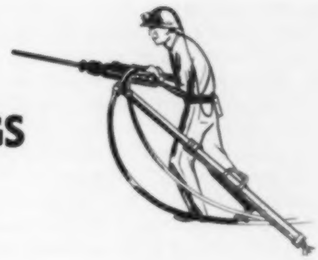
THE DRIFT OF THINGS



as followed by J. V. Beall

It was Columbus Day and towering over the statue of that great explorer in front of New York's Coliseum was the clean shaft of a Redstone rocket—the Santa Maria of space probing scientists. Inside the Coliseum bright-eyed boys and girls studied the displays as eagerly as the scientifically sophisticated frontiersmen of space. Rockets and missiles were dissected, combustion systems laid bare, and the electronic gadgets that control, test, record and transmit for Space Age vehicles were on display. This was the American Rocket Society's exposition: "Space Flight Report to the Nation."

"Space Flight" comprehends much more than rockets. It means communications, massive computing, optics, new combinations of materials, and a seemingly endless procession of specialties. For example the Telephone Co. showed its microwave reflector powered by solar cells. This sphere, placed in orbit around the earth could transmit 600 intercontinental telephone calls at the same time. With a number of microwave satellites orbiting, the whole world could view the same television program simultaneously. In mid-April 1962 a NASA rocket will place a microwave reflector in orbit, and it should not be long before submarine cables are obsolete.

Exhibitions of computers and electronic devices were way over our head so when we glimpsed the familiar sight of a huge granite boulder beside the Burroughs display we homed in like a Zeus on drone target. This was about a 1-ton mass of coarse-grained granite and we looked around hopefully for someone to explain its presence. Scanning people nearby for a rawhide neck cord with hand lense attached (sure sign of a geologist) we were disappointed. Finally we found a card which stated that the granite was a sample of rock from Mt. Cheyenne where Utah Construction and Mining Co. is excavating the underground NORAD Combat Operations Center for the U.S. Air Force.

We were trying hard to get our teeth into the outlook for metals in the Space Age. At the moment there is no clearcut boom in the offing as happened to aluminum in the aircraft industry. However, as demand for silver has moved up from uses created for electronic and photographic purposes, so could other metals. Two things stand out. Alloys, and processes for making and shaping them, are in dynamic evolution, and hardware and techniques developed for the Space Age are spinning off to consumer uses.

Consider the creation of buckling metals to cushion landing impact. General Electric's Space division demonstrates a tube 18-in. long by 4-in. diam. made of any of a variety of thin metal sheets. On subjection to impact test, the top half of the tube folds into neat pleats while the bottom half remains intact.

Use of arc plasma for making refractory metal melts has opened up hundreds of research channels. Such metals as chromium, molybdenum, hafnium, boron, columbium, tantalum, aluminum, titanium and others are powdered as silicides, nitrides, or carbides in new combinations and sprayed on nose cones or other rocket surfaces. An electromagnetic furnace ionizes a gas and the emerging small jet of ions, called *arc plasma*, melts and fuses the powder metal compounds at the tremendous heat of 25,000°F.

Several firms have gone into the new substance, pyrolytic graphite, and were exhibiting applications for space vehicles similar to those mentioned above. This substance is formed by

the thermal decomposition of a hydrocarbon gas on a hot surface. Pyrolitic graphite can be prepared with a wide range of physical properties; some of the more mundane of which are imperviousness and resistance to chemical and mechanical attack.

Beryllium foam is a new form of that metal with a honeycomb structure which may be used in missile wall structures. Aluminum, and titanium are coming in as major structural items such as fuel chambers.

Metals also come into the picture in solid fuels. Both aluminum and magnesium powders are mixed with hydrogen perchlorate to make the solid fuel used in the Minuteman ICBM. Aluminum grains, because of their faster burning, are used exclusively in first-stage rockets. We were interested in the manner of combustion of a solid fuel. After an explanation from the Thiokol Chemical Corp. representative we concluded that combustion of the fuel is similar to a bomb of dynamite sticks ignited by primacord—it all goes in a split second.

Atomic energy power sources will also come into the space flight program. There are two possibilities for the use of atomic power in rockets; one is for the propulsive force to lift the rocket off the ground and take it through the atmosphere; the other is for guidance and power source for the rocket in flight. The initial propulsion systems to date are simple devices whereby the hydrogen used to produce the reactive push for rockets is heated by the reactor. Additional shielding will be needed over that required for the radiation hazards of space flight. This test work, known as Rover, may eventually harness enormous atomic energy for putting gigantic pay loads in space.

Further advanced is work on reactors and radioactive isotopes for in-flight service. These come under the Snap program. The radioactive isotope electric generator provides current for instrumentation. Such a device generating 5 watts is in orbit. This current may also be used for powering the ionic propulsion guns which give small thrusts over long periods of time. Reactors in this service will provide more power, readily expended or banked, with a minimum of fuel.

Use of solar energy for powering the various electronic devices which are part of the information-gathering equipment of our space probes is becoming common place. Apparently the deathly cold of outer space increases the conductivity, or reduces the resistivity to almost zero, of ordinary electric conductors. Linde was showing super-cooled liquid gases for cryogenic uses in the space age. These liquid gases can make possible simulated conditions of outer space for testing solar energy applications.

A great big ball moved over our toe. It backed off and oscillated as if bowing and started back the way it had come. We followed for a bit but were arrested by a sign: "Launch a spacecraft at the moon." What an opportunity! Surrounded by kids, a dish-shaped table had the earth spinning at the center and away on the periphery, a moon scooting around. The kids could trigger a ball from the earth to intercept the moon if their timing was right. In the Hayden Planetarium on Central Park there is an arrow and a sign which offers unique directions: "To Solar System and Rest Rooms." We chose our direction accordingly and let the ball go to join the short-pants set in the space race.

There was no doubt of the target. Rocket design is for a moon shot. A number of moonscopes were on display with living and scientific accommodations suited to the absence of atmosphere and extremes of hot and cold. Advance capsules for landing devices on the moon and as weird an assortment of insect-like moon vehicles as ever you want to see were shown. The Sperry Rand "Prospector" was an intriguing device. It drills rock samples and analyzes them in its belly, sending back signals all the time. Most of these devices can be television-directed from the earth. Picture yourself on exploration in far Baltistan. Instead of sending the boy to fetch a sample from yon mountain, you send your S-R Prospector and get your sample and analysis without leaving camp. (One of the consumer applications mentioned earlier.)

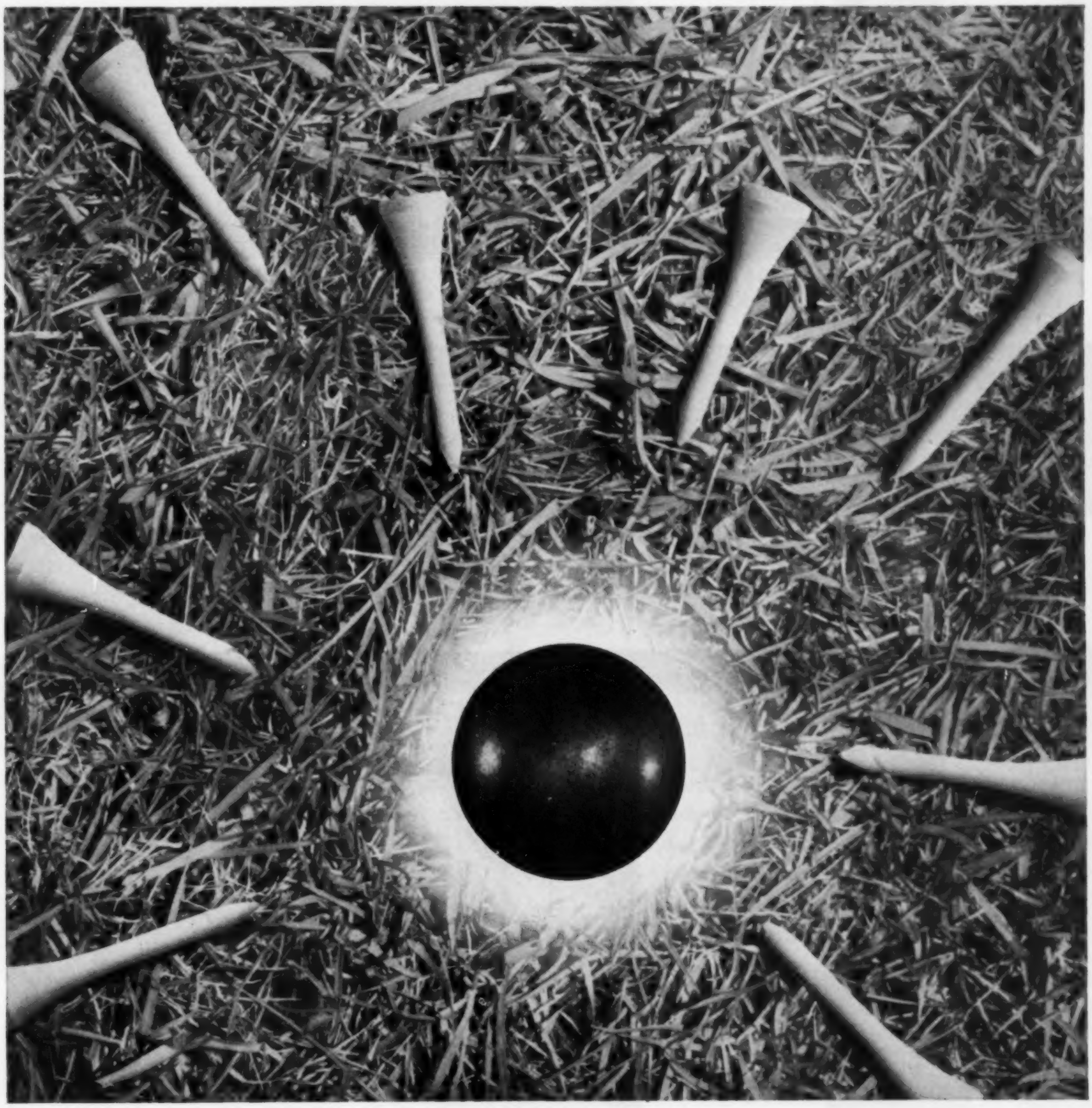
The moon always presents nearly the same face to the earth, which means that its revolution on its axis takes the same time as to complete its orbit of the earth. This face has been photographed through telescopes. Most pictures of the moon's face are montages of photographs taken during the first and last quarters which show up details better than a full face picture. The far side of the moon is only known by photographs taken in October 1959 by Sputnik III.

The best-known features of the moon are its craters. These are of all sizes up to 200 km in diameter. Differences of elevation are as great as six miles. The floors of craters may be higher or lower than the outside terrain. The large circular features are called *maria*, and are the result of collisions of objects with the moon. The smaller craters may have resulted from gas emanations from the interior. Both phenomena are thought to have been transpiring intermittently during a long span of time. However, the effect of impact in some collisions may have generated enough heat to cause craters to have formed subsequent to the collision.

The origin of the moon is probably the most intriguing puzzle that awaits solution. Darwin hypothesized at the end of the 19th century that it came from the earth. His theory was to explain the differences in density of the earth and moon (5.52 and 3.34 respectively). But latter day scientists have been unable to explain the mechanics of how this lighter crust of the earth was thrown off. Kelvin said in a paper published in 1862 that the terrestrial planets and moon solidified from molten masses. Urey and others think the discovery of radioactivity offers different explanations for heat in the interior of the earth. Observations of escaping gases from the interior of the moon and conclusions that it is getting hotter rather than cooler tend to detract from the Kelvin theory.

Today we can calculate that the density of the moon is comparable to that of the sun if the gases are removed. The planets on the other hand have densities which range from 4 to 6. Scientists speculate that the moon may have formed in an early stage in the development of the solar system while the planets were created later, accumulating heavier materials such as meteorites from space and by fractionation in the earth or planetary masses by collisions which drove off lighter elements. If it should be true that the moon is older than the earth and other terrestial planets, a great many mysteries of the solar system and even the universe may be explained by reaching it.

Next month this column will be written by Paul C. Merritt, managing editor; who has recently returned from Alaska and will introduce our December issue which is devoted to that subject.



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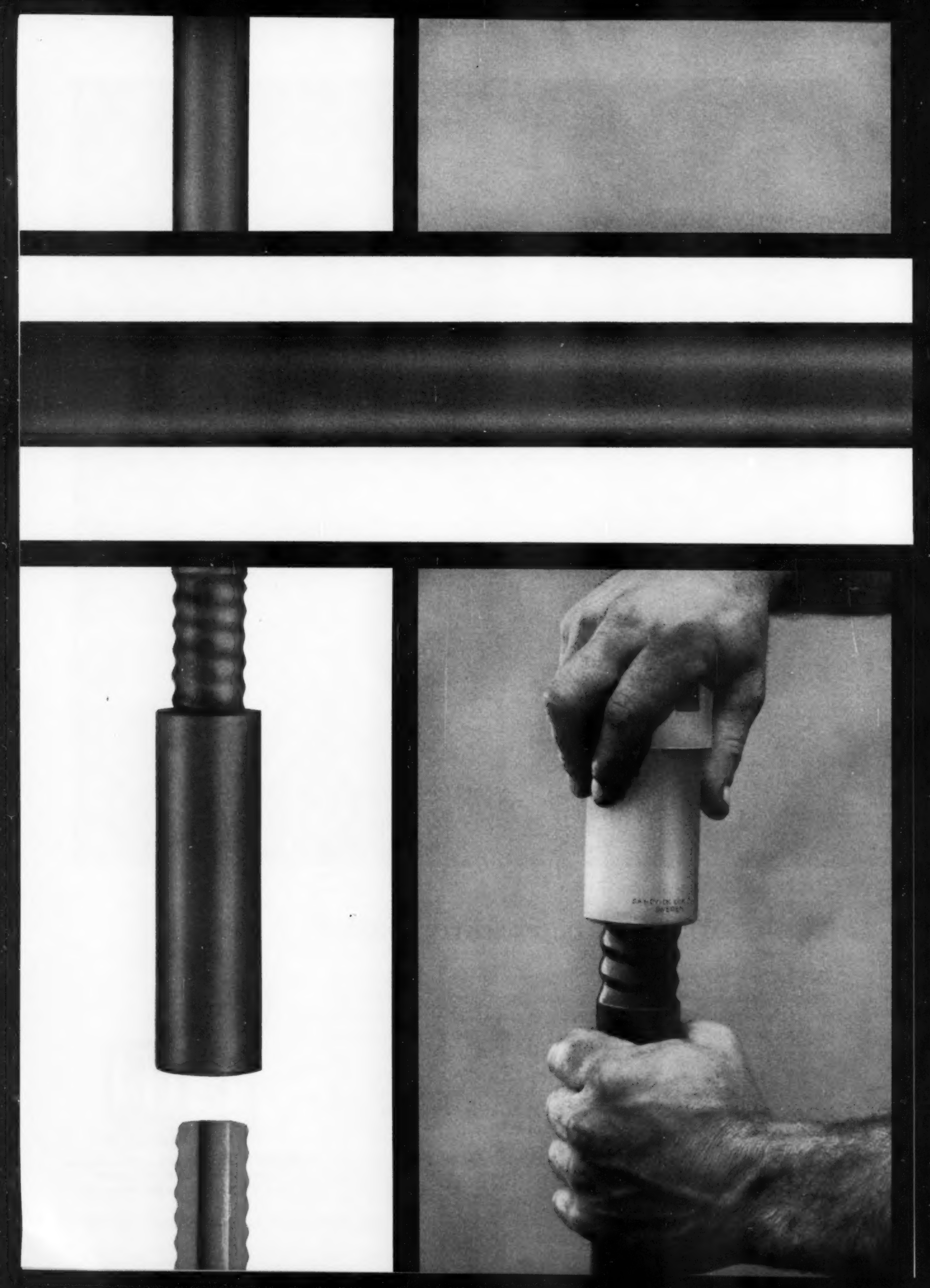


PRODUCTIVITY IN THE LEAD-ZINC INDUSTRY

by H. M. CALLAWAY

There are key words common to Government and the minerals industry, the use of which immediately spark interest, argument and confusion. Among these is **productivity**, *a term ranking for widespread misunderstanding with* **mineral self-sufficiency** *and* **mineral conservation.** *Each interpretation of these words tends to emphasize a single aspect and either minimize or ignore the complex dynamic system of things that influence the Nation's mineral productiveness. This paper*[1]*, abstracted from a monograph on lead now being prepared for publication by the Bureau of Mines, not only sheds light on the trend of productivity in the lead-zinc mining industry but it presents the basis for forming a common general notion of what the term* **productivity** *implies.*

It is widely accepted that productivity in the lead-zinc mining industry has increased over the years. That the increase is real seems evident. But what have been the magnitude and causes of the productivity rise, and what separate factors are responsible for these changes?

Answers are made difficult by discontinuous indexes and non-uniform information. Furthermore, the inherent complexity and highly individual nature of mining operations (particularly those which, like lead and zinc, depend upon selective underground techniques of ore extraction for the bulk of production) make it extremely difficult to establish norms of productivity that have meaning for large groups of operations such as those within one nation. On the other hand, despite these drawbacks, available statistics included herein seem to be quite useful in arriving at general conclusions concerning productivity if the limitations are clearly recognized and there is some common understanding of definitions. Perhaps the significance of productivity should first be discussed.

H. M. CALLAWAY, Member of SME, is a physical scientist, Bureau of Mines, U.S. Department of the Interior, Washington, D. C.

SIGNIFICANCE OF PRODUCTIVITY

Webster defines productivity as the quality or state of being productive. The economist defines it in more precise, quantitative terms but usually limits its expression to the factor of labor. Thus, productivity has been defined as the ratio of productive output to the man-hours or man-years worked to accomplish the production.

[1] This paper is abstracted from *Lead*, A Materials Survey, publication pending, Bureau of Mines, U.S. Department of the Interior, Washington, D. C. Mr. Callaway is a physical scientist for the Bureau of Mines and author of the lead monograph.

If the implications of the definition are recognized, productivity is a sound basis for judging many factors, most of which are unrelated to the intrinsic productiveness of labor. For example, *tons-per-man-shift*, a widely used gauge in lead-zinc mining, not only measures the productivity of the below-ground worker but also measures the efficiency of the combination of equipment, labor, capital, management, raw materials and power. If tons of lead concentrate are compared with man-shifts, two additional factors are introduced—1) efficiency of the mill and 2) grade of the ore. If the output in the ratio is changed from that of concentrate production at a single mill to production of refined lead of a nation, the resulting productivity figure measures the net result of a complex combination of factors that include considerations of the geology and mineralogy of the ore in every mine contributing lead to the industry, the level of technology of exploration, mining, smelting and refining in all lead industry establishments, the skills and energy of labor and management, the effectiveness of invested capital and the efficiency of the combinations of crude ore, equipment, labor, power and dollars that function at each plant to give rise to the nation's lead supply.

Perhaps a less restrictive definition of productivity would more accurately relate productivity changes to underlying causes. In a broad sense, unit productivity in the lead industry may be considered the ratio of the industry's lead output to the industry's total input in units of capital, labor and raw materials (including ore and power). In addition to time units, number of employees, and quantity of output, factors that should be accounted in such an expanded productivity expression should include the following:

Grade of Ore: An increase in the grade of ore increases productivity independently of almost all other factors. Often the mine operator, to the limit permitted by the geologic nature of the ore deposit, must counter unfavorable productivity factors, such as inefficient labor, expensive equipment and supplies, and low metal prices, by "high-grading". He may thereby maintain or increase the operation's productivity, expediently sacrificing long-range efficient and complete ore extraction in order to remain competitive.

Capital Investment: The level of capital investment determines the level at which all other production factors bearing on productivity may be applied.

Power Equipment and Supplies: The kind and quantity of these items act directly through their inherent qualities, and indirectly through their effects on labor's usefulness, to determine productivity.

Technology: This factor is the underlying support of production. The level of technical know-how determines the effectiveness of the combinations of labor, power, equipment and supplies. Technology also has profound indirect influences on productivity through its relations to discovery of economic lead-bearing deposits, progressive development of new equipment, increased efficiency of units of power, increased quality of supplies, and other factors.

Management Skill: Management is often considered a specialized division of labor. Certainly, this is a valid generalization. In this discussion, however, it seems wise to consider management as a separate productive factor functioning to coordinate and regulate the factors of labor, capital, raw materials, and technology.

Market Value of Product: If gauges of lead productivity are based on dollar-value of the product rather than on the product's physical volume, then two additional factors should be considered to influence productivity: 1) a change in the price of lead proportionally changes the productivity independently of all other factors; 2) the value of the dollar itself has changed over the years so that the value of the product entering productivity figures must be reduced to terms of constant dollars when productivity figures of different years are compared. Use of constant dollar terms prevents the productivity figures of the later years from being inflated.

Derivation of an expression to encompass all these factors in quantitative terms is probably impractical and certainly beyond the scope of this paper. The preceding discussion does, however, point up the relations in qualitative ways and induces the conclusion that *productivity is an aspect of the combination* of all the factors of production.

TRENDS IN PRODUCTIVITY

From the data assembled by the Works Progress Administration it is apparent that productivity in lead and zinc mining and milling in the U.S. increased from 10.4 tons of lead and zinc per man-year in 1870 to 53.0 tons in 1929. This increase was accompanied by an increase in use of power at mines from 0.053 average rated hp per ton of lead and zinc in 1870 to 0.259 in 1929.

Table I gives productivity indexes for 1926-49 as determined by the WPA and the Bureau of Labor Statistics. The two segments of the indexes that join at 1935 are not strictly comparable because the WPA series from 1926 to 1935 excludes the reclamation of old tailings, whereas the BLS series from 1935 to 1949 includes them. Furthermore, the WPA employment data exclude, and the BLS employment data include, labor employed at ore-dressing plants. Thus the 1926-35 series presents a truer picture of mine labor productivity than the 1935-49 series, because low-grade old tailings from the Tri-State area alone constituted about 30% of total tonnage of all lead-zinc mill feed in the U.S. from 1935 to 1944, but declined to about 7% of all materials milled in 1949.

In 1954, the United States Tariff Commission assembled a comprehensive report on the lead-zinc industry.[3] Statistics from this report indicate that in 1939, 246 domestic lead and zinc mines and 120 mills produced and processed 16,317,000 tons of crude ore that yielded 362,204 tons of lead; 533,099 tons of zinc; 5,723 tons of copper; 11.5 million oz of silver; and 61,538 oz of gold. The total mill value of these products was $62,652,000. The output was accomplished by 15,640 production employees working 32,283,000 man-hours. In that year 0.52 man-hour was required to produce one dollar's worth of

[3] Lead and Zinc Industry, Report 192, U.S. Tariff Commission, 1954.

Table I. Indexes of Production, Employment and Recoverable Metal in Lead and Zinc Ore and Tailings Mining and Milling in the U.S. 1926-49* (Indexes 1939 = 100)

Year	Production: Recoverable metal	Production: Ore and tailings	Employment Man-hours	Recoverable Metal: Per ton of ore and tailing	Recoverable Metal: Per Man-hour	Tons mined and milled per man-hour
1926	151.4	125.4	218.6	120.7	69.3	57.4
1927	139.4	118.1	188.5	118.0	74.0	62.7
1928	143.4	107.1	176.0	133.8	81.5	60.9
1929	146.0	117.6	190.3	124.1	76.7	61.8
1930	131.7	101.4	139.8	129.9	94.2	72.5
1931	100.2	66.2	89.2	151.4	112.4	74.2
1932	66.0	41.0	58.2	160.8	113.4	70.5
1933	73.8	47.5	61.1	155.3	120.8	77.8
1934	82.7	66.5	73.9	124.5	111.9	89.9
1935	86.3	76.9	86.7	112.2	99.5	88.7
1936	96.2	97.5	102.7	98.7	93.7	94.9
1937	110.4	118.1	122.5	93.5	90.1	96.4
1938	89.2	85.3	91.4	104.6	97.6	93.3
1939	100.0	100.0	100.0	100.0	100.0	100.0
1940	112.7	116.3	116.9	96.9	96.4	99.5
1941	122.0	133.7	124.1	91.2	98.3	107.7
1942	127.4	144.3	141.0	88.3	90.4	102.3
1943	120.8	152.5	160.4	79.2	75.3	95.1
1944	114.8	158.0	145.7	72.7	78.8	108.4
1945	100.6	144.3	127.9	69.7	78.7	112.8
1946	90.9	135.0	129.5	67.3	70.2	104.2
1947	103.7	118.2	135.5	87.7	76.5	87.2
1948	103.4	96.8	125.7	106.8	82.3	77.0
1949	101.0	92.8	118.7	108.8	85.1	78.2

* Data for 1926-35 from Works Progress Administration using Bureau of Labor Statistics indexes for 1935; data for 1935-49 from Bureau of Labor Statistics.

Table II. Productivity Index, Lead and Zinc Mining, Based on lbs of Recoverable Metal per Man-Hour, 1947-49 = 100*

Year		Year	
1935	122.1	1947	93.2
1936	115.1	1948	100.9
1937	112.0	1949	106.9
1938	120.6	1950	118.4
1939	123.3	1951	108.5
1940	118.9	1952	103.5
1941	120.3	1953	108.1
1942	110.9	1954	106.8
1943	91.8	1955	108.7
1944	95.8	1956	109.1
1945	96.4	1957	114.6
1946	85.7		

* Source: Bureau of Labor Statistics Series was terminated in 1957.

mine-mill product. Apparent tons-of-crude-ore produced and processed per man-shift was 4.04 tons. Average hourly earnings of the production worker was $0.62.

In 1952, 313 lead and zinc mines and 113 mills produced and processed 22,919,000 tons of crude ore that yielded 346,359 tons of lead; 596,185 tons of zinc; 12,946 tons of copper; 16.5 million oz of silver; and 129,536 oz of gold. The total mill value of these products was $225,384,000. The output was accomplished by 18,060 production employees working 43,791,000 hours. In 1952 an average of 0.19 man-hour was required to recover one dollar's worth of mine-mill product. Apparent tons-of-crude-ore produced and processed per man-shift was 4.19 tons. Average hourly earnings of the production worker was $1.95. The Wholesale Commodities Price Index indicates the 1952 dollar was worth in materials purchasing power approximately 45% of the 1939 dollar.

In 1958, 184 mines and 60 mills produced and processed 14,359,000 tons crude ore that yielded 250,977 tons of lead; 373,730 tons of zinc; 11,000 tons of copper; 64,000 oz of gold, and 10.2 million oz of silver. Total value of the mill products was $103,-600,000. This production was accomplished by 8,682 production and related employees working 17,403,-000 man-hours. In 1958, an average of 0.17 man-hour apparently was required to recover one dollar's worth of mine-mill product, a figure essentially the same as that of 1952. Apparent tons-of-crude-ore produced and processed per man-shift was 6.60 tons. The Wholesale Commodities Price Index indicates the 1958 dollar was worth (in materials purchasing power) approximately 93% of the 1952 dollar and 42% of the 1939 dollar.

W. A. Vogely (in "Review of the Minerals Industries," a chapter from Bureau of Mines *Minerals Yearbook 1956*) computed an index of productivity using employment, average hours and recoverable content of domestic production. Succeeding *Minerals Yearbook* chapters update the index series. This index shows the recoverable metal per man-hour in the past years as follows: (1949 = 100); 1950 = 110; 1951 = 101; 1952 = 98; 1953 = 100; 1954 = 100; 1955 = 103; 1956 = 102; 1957 = 105; 1958 = 111; 1959 = 115. The Bureau of Labor Statistics in 1957 updated a similar index for the period 1947-57, giving an index covering the period 1935-57 using the three-year period 1947-49 as a base. The BLS index appears in Table II.

CONCLUSIONS

The various indexes indicate that productivity varies considerably from year to year. Largest increases in productivity occurred prior to World War II. Since 1939, productivity trends have been mixed, but generally are upward. The figures and interpretations are related to the way in which productivity is defined and to the time interval chosen for study.

If productivity is expressed in terms of metals recovered from lead and zinc ores per man-hour, figures from the sample years indicate productivity has increased considerably, but not proportionally with time. The ratio of tons of crude ore mined and milled per man-shift supports the conclusion that productivity has increased considerably, but in cyclic fashion. Table II from a Bureau of Labor Statistics series shows clearly the cyclic nature of productivity changes but casts doubt that long-range productivity gains have occurred since the 1930's. If the value of the product in current dollars is used as a gauge, it seems apparent that productivity has increased very rapidly since 1939; but if dollar values are reduced to equivalent dollars, the increase is much less pronounced.

The cyclic nature of productivity changes is due, at least in part, to the characteristics of the business cycle. When the demand for lead is increasing, the high-cost, low-efficiency marginal mines are put into production; lower grade ores are mined; and long-range projects, necessary for continued operation but not directly contributory to current production, are undertaken (mine development, for example). The result is a lowering of the unit productivity of the industry as a whole. Conversely, declining demand for lead with attendant declining metal prices causes the low-efficiency and low-grade mines to close. The remaining operators mine more selectively, and immediately curtail unproductive exploration and development work. Hence, the statistics generated by the declining market give rise to higher productivity figures.

ELECTROTHERMICS:

New Way of Breaking Rock?

The General Electric Co., in cooperation with the Montana School of Mines and under a research grant from the Anaconda Co., is presently experimenting on a new non-explosive method of breaking rock with radio-frequency electrical power. The method is known as *electrothermal forcing.*

It must be understood that present equipment has not been designed to perform primary blasting functions. Its conceived use will be restricted to small pieces of rock too large to pass through a chute or grizzly. However, even this use is still far in the future. Experiments to date have been limited mostly to rock smaller than 18 in.

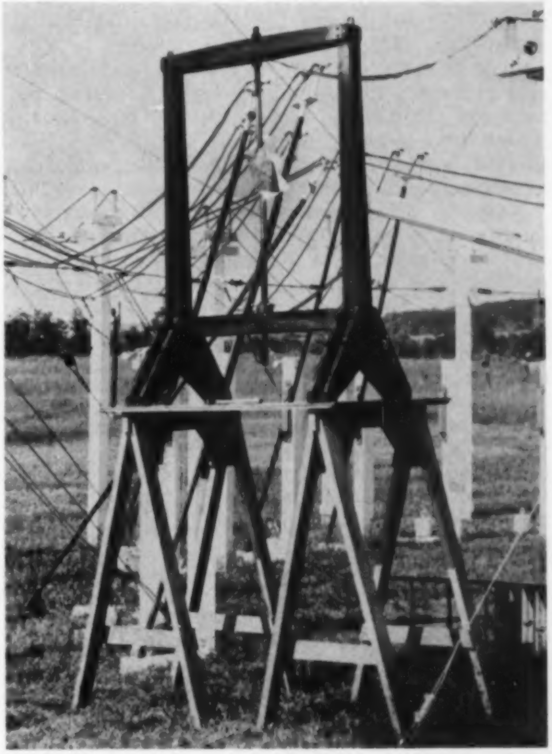
Breaking of the rock is accomplished by using high-frequency, high voltage and nominal power to establish a conducting path through the rocks. After the conducting path is established, the rocks can be broken by extending the time of high-frequency power dissipation or by a pulse of direct-current energy dissipated in the rock. The dissipation of the electrical energy raises the temperature along the conducting paths; thus it is thermal expansion that actually cracks the rocks.

This new process is essentially based on the fact that solid rock is composed of small particles of water trapped in the crystalline structure of the rock which can provide a conductive path for electricity. Because of the low initial resistance in metal-bearing ores, less force would be required to break the rock.

The cracking that takes place actually only breaks the rocks in three or four smaller pieces. Breaking of large material could be accomplished by the expenditure of greater time and power. However, this appears to be uneconomical at the moment.

The relationship among energy requirements and the size, shape and electrical characteristics of various rocks has not yet been established. Further experimentation will provide these data.

Based on present knowledge, the electrical equipment required for this process consists of an enclosure 6 ft wide, 3 ft high and 90 in. deep. It includes a radio-frequency generator, capacitor storage equipment, suitable contactors and relays for transferring from *r-f* source to capacitor discharge source, operating from 220 to 440 voltage, three phase, 60 cycle, to power source sufficient to supply approximately 50 kilowatts. This equipment weighs approximately 5000 lbs and must be portable. It should be noted that this *r-f* generator will undoubtedly detonate blasting caps in the vicinity. Operational underground safety procedures must be adopted if this equipment is used. It is felt that the high-frequency energy would generate radiations outside limits allowed by the Federal Communications Commission.



The simple equipment and small rock sample attest to the infancy of electrothermic rock-breaking research. The mutual effect of rock type, rock size and necessary power requirements pose serious hurdles to researchers.

Experimental work has not been done yet on large boulders. Although the researchers see no reason why this process would not be applicable to them, they don't know the amount of power required for rocks in this range.

Following preliminary testing completed at the Electrical Laboratory of the Montana School of Mines under the supervision of Francis M. Young, experimental work on the process was done by General Electric's Engineering Laboratory at Schenectady, N. Y., under the auspices of the Industry Control Department.

PROGRAMMING U. S. BUREAU OF MINES' MULTIMILLION-DOLLAR MINERALS RESEARCH

by CHARLES W. MERRILL

Minerals research by the U.S. Bureau of Mines embraces the mining and metallurgical problems of some 80 metals and nonmetals excluding the mineral fuels. It requires the energies and talents of about 1400 persons, almost half of whom are professionally trained in the physical sciences or engineering. Of approximately $13 million appropriated to the Bureau for minerals programs in Fiscal Year 1962, 76% has been allotted to technologic research and 24% to resources examination and appraisal. In addition, almost $2 million will be made available to the Bureau for minerals research from other Government sources and from private organizations that wish to utilize Bureau experience and capabilities in cooperative studies.

Research programming is organized on a commodity basis and is carried on by a headquarters staff of physical scientists assigned to specific commodities and identified as commodity specialists. Research is carried out by a staff of engineers, scientists and technologists under supervision of Research Directors, working in research centers and laboratories or out of field offices placed strategically throughout the country. Each commodity program fits into a coordinated approach to the national mineral-supply problem and extends utilization through knowledge of mineral characteristics. Research projects are grouped as: 1) mining research, performed at Mining Research Centers, Laboratories or Offices, and 2) metallurgical research, conducted at Metallurgy Research Centers or Laboratories.

The Bureau's work parallels research elsewhere, except for these important differences: 1) research must be within Bureau of Mines authority as set forth in its Organic Act; 2) funds are recommended by the President and appropriated by Congress annually; 3) staff is recruited and employed under exacting regulations of United States Civil Service; 4) results of research are public property and under constant general scrutiny.

The Bureau's Organic Act of 1910 authorized and directs it ". . . to make diligent investigation of the methods of mining, . . . the treatment of ores and other mineral substances, the use of explosives and electricity, . . . and other inquiries and technologic investigations, pertinent to said industries . . . ." The breadth of this authorizing language places little limitation on mining and metallurgical research permitted the Bureau. However, certain work is assigned to other Federally-supported research institutions, such as the National Bureau of Standards and the Atomic Energy Commission, in order to minimize duplication of effort. Moreover, the Bureau reviews reports on work conducted elsewhere, particularly in private laboratories, so as to avoid duplicating results.

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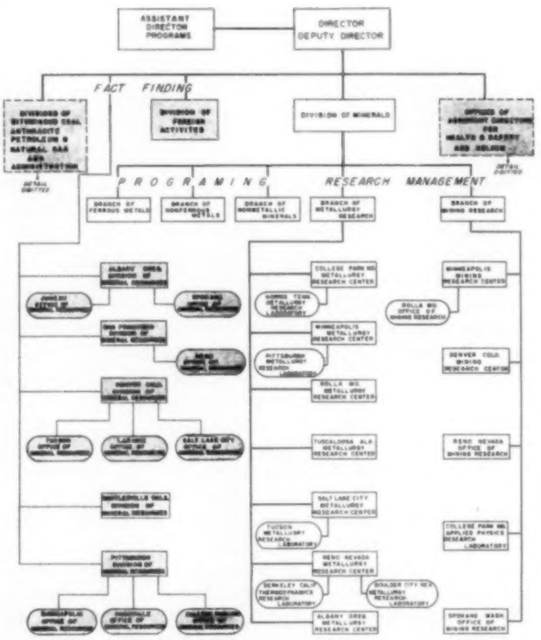

Organization chart of the U.S. Bureau of Mines.

Program development begins with the fundamental assumption that the mission is to help assure an adequate, dependable and continuing supply of minerals for an expanding population, a rising standard of living, and national security, produced under conditions minimizing hazards to health and safety of workers in mineral industries. Problems inherent in current and foreseeable demand are evaluated and potentialities of mining and metallurgical research approaches for assuring adequate supplies of each commodity are appraised. The budget finally proposed to Congress is derived from this comprehensive and intensive study of all available information.

FACT-FINDING FOR RESEARCH PROGRAMMING

Commodity specialists conduct surveys of resources, reserves, productive and processing capacities, production, imports and other related factors. They compile a parallel record of consumption and exports. In addition, they appraise the impact on the supply-demand-price balance of such factors as new technologies in production and consumption, tariffs, subsidies, quotas, noncommercial stockpile programs, international commodity agreements, as well as such pervasive considerations as population increase, the gross national product trend and major international policy reorientations. Finally, all these data are related so that what

emerges is not only a record but also a series of trends which form bases for projections.

Although this information is primarily for use in formulating and guiding the technical research program, it also provides, as a byproduct, a major fact-finding service. This service reaches the public primarily in the form of interpretive reports published annually in the Bureau's *Minerals Yearbook*, in some 400 *Mineral Market Surveys* (mainly statistical), in definitive *Materials Surveys* that present detailed information on individual commodities, in other Bureau reports published mostly as *Information Circulars* and as trade journal articles and public addresses.

Data on domestic reserves and mine production are collected by Mineral Resources Offices in the field. Likewise, most information on foreign production, consumption and trade is compiled by others than the programming group. However, the commodity specialists do collect domestic mineral-consumption data on a large scale by direct canvassing of industry. Each specialist acts as a focal point in the Bureau for supplying information and advice on his commodity.

RESEARCH PROGRAMMING AND BUDGET

In addition to meeting the basic national supply problem, the Bureau's program has a broad purpose which is summarized as follows: 1) appraise the U. S. mineral position to provide Government and private industry with facts needed for wise direction of their respective activities; 2) develop technologies for exploiting currently submarginal mineral resources that will be required to maintain an adequate, dependable and continuing supply of mineral raw materials; 3) find new or wider uses for abundant mineral resources to relieve the drain on materials in short supply, and promote the establishment of new industries based on the use of plentiful minerals; 4) develop substitutes for scarce minerals and metals to relieve strategic dependence on overseas sources, and to keep industrial and social progress from being handicapped by raw material deficiencies; 5) conserve the Nation's mineral resources by efficient exploitation and wise use, including reuse of reclaimable scrap materials; and 6) search among mineral commodities and products for properties and combinations of properties that will afford useful materials to designers faced with problems in building structures and fabricating devices for the new and exacting conditions of the Space Age.

The commodity program statement itself opens with a background section giving information about the commodity. This is followed by brief sections on Outlook, Problems, Avenues of Attack on Problems and, finally, Program for the Bureau of Mines. (It is noteworthy that the first minerals program manual created so much interest among outside critical reviewers that the Bureau was prevailed upon to publish the basic information on mineral commodities as *Bulletin 556*—Mineral Facts and Problems in 1956, now in its second edition under the same title as *Bulletin 585*.)

These commodity program statements which are updated systematically are distributed in the Bureau, and project proposals are invited to carry out the objectives as set forth. Proposals are relatively specific and normally deal with a single technical approach on a particular commodity problem. Most proposals originate in the Research Centers and Laboratories. They are evaluated to determine if they are within the Bureau's program, and what contribution they are likely to make toward the solution of a commodity problem.

The next stage is selection of proposals for the formulation of a budget. Such selection is not a simple matter, for the question has been raised as to the practicality of comparing widely dissimilar research proposals. The question before the Bureau is not how it will make a precise evaluation of the national interest between two proposals but rather, knowing it must make a decision in recommending research financing between them, what will be its rationale for justifying its position. The proposed budget emerges as a balanced evaluation of commodity need, functional proposals and research capabilities. It is reviewed at various levels of Government in the Bureau, the Department of the Interior, the Bureau of the Budget (representing the President in balancing the various activities of the Administrative branch), and the Congress, which includes separate committees of the House and Senate and, finally, floor action by each of the two branches. After reconciling differences, the Congress sends an approved appropriation bill to the President for signature.

AUTHORIZATION OF RESEARCH WORK

When the funds for a new year's work become available, authorizations are written describing the research objectives, consistent with the proposals on which they are based and modified by statements made during the program and budget approval processes. A research authorization conforms to the budget structure and confines itself to work for a single Research Center. The division of funds among separate research objectives is in the hands of the responsible Research Director, acting under the guidance contained in the authorization and with due regard for operating conditions.

On receiving authorizations, the Research Directors prepare work schedules outlining proposed operating procedures. Preparation of work schedules by those who will direct the work promotes efficiency by permitting full weight being given to local operating conditions. Work schedules are binding except that they may be revised by Research Directors at any time, provided revision is within limits of authorization and is promptly reported to Headquarters. Thus, research objectives are set firmly by program planners and managers at Headquarters, yet operational flexibility is preserved throughout the budget year in the hands of local Research Directors.

As research proceeds, progress is reported periodically, usually on a quarterly basis, with intervening monthly reports on special developments. At the end of the fiscal year a summary report, reviewing and analyzing the year's accomplishment and recommending work for the future, is made for each research project.

As important phases of research are completed, results are published normally in the Bureau's *Report of Investigations* and *Bulletin* series, as well as articles in technical journals, speeches and other media. However, all substantial research findings are published as promptly as possible in some Bureau series. This policy assures proper indexing and library custodianship so that the public will have easy and permanent access to the research findings of the Bureau of Mines.

CINNABAR AT CORDERO

Where They Find It . . . How They Find It

by ELWIN L. FISK

First discovered and claimed in 1929, the Cordero cinnabar deposit lies 11 road miles southwest of McDermitt, Nev., near the Nevada-Oregon boundary. The name "Cordero" means "little lamb" in the Basque language and is symbolic of the fact that the first ore specimen was found during the lambing season.

The Bradley Mining Co. held the property for several years during the early thirties, but it was not until 1939 that Cordero Mining Co., a subsidiary of Sun Oil Co., entered the picture. The company, then known as Horse Heaven Mines, Inc., conducted preliminary work in 1940 which proved enough near-surface ore to warrant the construction of a mill during the following year. By 1943, Cordero was being rapidly depleted when deeper churn drilling intersected the large underground orebody that is still being mined today.

REGIONAL STRUCTURE

Cordero mine is situated on the southeast corner of an elevated and tilted graben block (Fig. 2). The block is bounded on north and south by east-west normal faults while the eastern edge is bounded by a northwesterly-striking reverse fault. This latter fault can be traced by a scrap that separates the graben block from the main north trending valley lying to the east. After late Miocene, when the area was a basin of deposition for vitric tuffs and lake beds, the graben block was uplifted and the central area of pyroclastics was eroded away to expose an earlier andesite flow through which McDermitt Creek and Washburn Creek cut sharp canyons.

The 8° tilt of the block can be measured by the dips of remnant lake beds and tuffs at both the Cordero and Bretz mines. Cordero is now situated about 200 ft above the main valley floor, while the Bretz mine on the north side of the block is approximately 2000 ft above the valley floor. Present topography suggests vertical movements of 300 to 4000 ft.

Most ore found at the Bretz property has been in the previously mentioned lake beds adjacent to the boundary fault. The orebodies at Cordero are found in rhyolites along two roughly parallel faults, M-fault and Harper fault, that cut off the corner of the graben block at a 45° angle. The width of the block between the Bretz and Cordero mines is about six miles.

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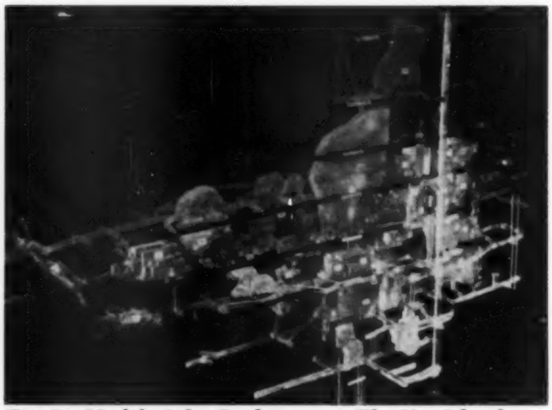


Fig. 1—Model of the Cordero mine. The No. 2 level is at top of the model and No. 9 level is shown at the bottom.

VOLCANIC FORMATIONS AT CORDERO

In this region, volcanics vary from rhyolites to basalts with metamorphic rocks lying to the east in the Santa Rosa range and granitic rocks being found to the west beneath the volcanics of Disaster Peak at the north end of Kings River Valley.

In the ore-bearing area of Cordero, all rhyolites have almost identical mineralogic composition, being composed of sanidine and quartz with no visible accessory minerals. However, they do vary in texture and quantity of phenocrysts. The age relationships of the various rocks are obscure, particularly in view of the fact that some of the members may be intrusive.

Footwall Rhyolite: Apparent thickness of the footwall rhyolite is at least 450 ft. A dense aphanitic rock, its most notable feature is that the glass has been completely devitrified. Overlying this rock with no sharp dividing line is a banded vitric rhyolite that may possibly be the top of the footwall rhyolite. A fresh specimen of this rock has a light green color with a pitchy luster. Alteration first changes this color to a light violet, then subsequently to various shades of brown, red and yellow.

Rhyolite Pitchstone: Below the footwall rhyolite is a highly altered rhyolite pitchstone which has been exposed in the footwall workings on No. 8 level of the mine (see Fig. 3). When relatively unaltered it is almost black, but usually it is light green from the argillic alteration and addition of water. The contact between the pitchstone and the

overlying footwall rhyolite is very irregular, but in general, it dips to the northeast. In one crosscut, the altered pitchstone appears to form sills and dikes above the contact in the footwall rhyolite.

Cordero Rhyolite: The Cordero rhyolite porphyry forms the hanging wall of the steeply dipping M-fault and is the host rock of the cinnabar mineralization. It has been exposed from just below the surface down to the No. 9 level, a vertical distance of about 800 ft. Throughout this section it is a gray banded porphyry with ¼-in. white sanidine phenocrysts. The banding, accented by argillic alteration, is usually parallel to the nearest minor fault or fracture, but it becomes less apparent as the distance from M-fault increases.

Fault breccias associated with the major and minor faults in the rhyolite have been found as thick as 20 ft, but they can be traced laterally or vertically over only a very short distance. In areas where the alteration of these breccias has been intense, they appear similar to ordinary agglomerates.

Opalite: When the Cordero deposit was discovered, the only outcrops were opalite masses which were similar to those of the Opalite mine that was then operating in Oregon. "Opalite" is strictly a miner's term, as this material is usually a brecciated or tuffaceous rhyolite that has been recemented and/or replaced by quartz and chalcedony. At Cordero, the opalite is a brecciated rhyolite that has been silicified. The roots of the opalite have been found approximately 140 ft below the surface. Specimens have illustrated at least four periods of brecciation and recementation, but seven periods are suspected. The distribution of this silification is definitely along various faults and fractures. Since there were no especially favorable beds at Cordero, the silicified masses usually have as great a vertical extent as they do a lateral extent.

GEOLOGIC STRUCTURES

M-fault, a normal fault which is the major ore-controlling structure, strikes from N45°E to N50°E, dips from 80° NW to 90°, and contains five feet of clay gouge or breccia. The change in strike occurs over a lineal distance of 100 ft by warping and faulting, and the main orebody lies against the concave surface resulting from the change in direction. The dip of the fault slowly increases with depth, becoming vertical between Nos. 7 and 8 levels. There are many offsets in this fault, the largest showing a 20-ft displacement.

Harper fault, another normal fault lying about 700 ft southeast of the M-fault, is nearly parallel to the latter but is almost vertical in all observed exposures. An old open pit and a new underground deposit (the Corderito orebody) now being developed are situated along this fault. Little is known of the open pit workings, but recent underground exploration has already developed at least 10,000 tons of ore averaging 12 lbs of mercury per ton.

Striking N62°W and dipping 35° to 45°NE, the "470 fault" is the limiting structure to the southwest in the Cordero rhyolite. A normal fault, it is considered to be pre-mineral because the last movement produced a lens-shaped opening, found on the No. 5 level, up dip from which has been found a good orebody in other lenses and wedges.

The last major fault is the "412 fault," the strike of which is roughly parallel to M-fault but converging with it above the No. 2 level to the northeast. The dip of the fault is about 45°NW. Although not as strong a structure as the previously

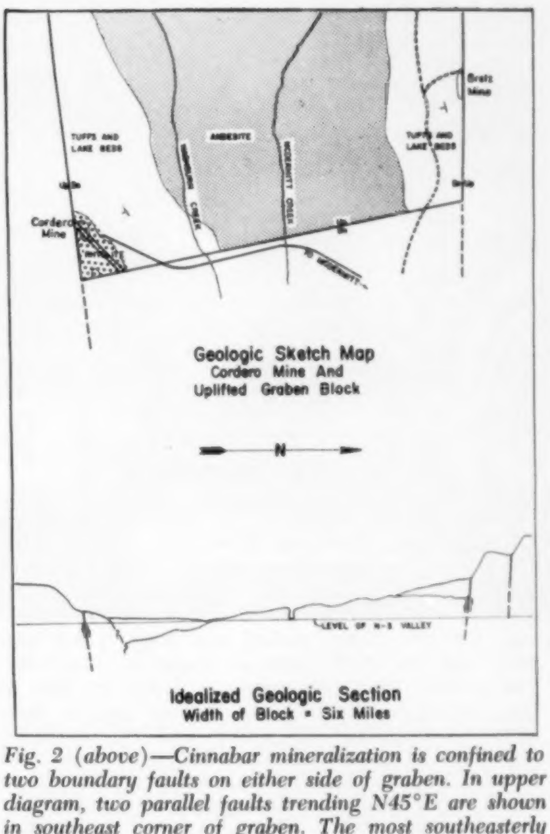
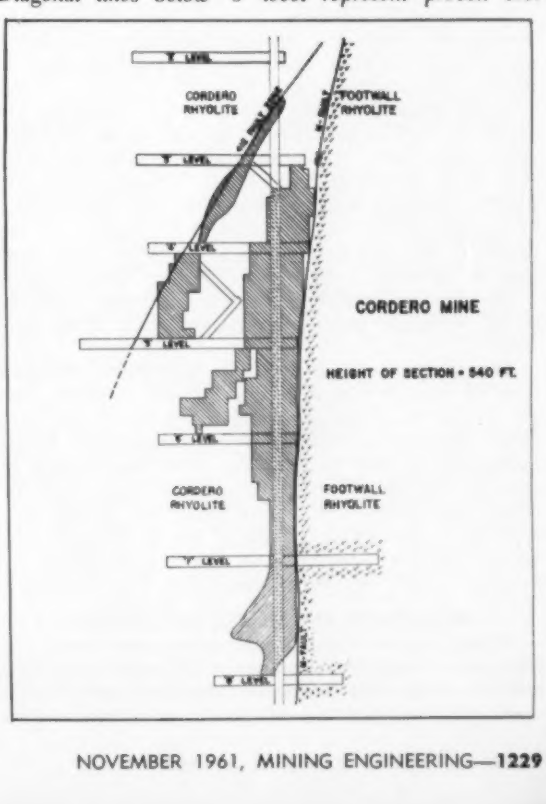


Fig. 2 (above)—Cinnabar mineralization is confined to two boundary faults on either side of graben. In upper diagram, two parallel faults trending N45°E are shown in southeast corner of graben. The most southeasterly of which is the Harper fault. Located 700 ft to the northwest is M-fault. "470" and "412" faults not shown.

Fig. 3 (below)—Cross section of Cordero mine. Shaded areas between levels '2' and '8' show worked out portion. Diagonal lines below '8' level represent proven ore.



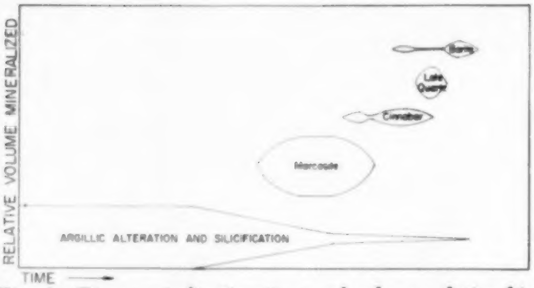


Fig. 4—Diagram indicating time and volume relationship of alteration and mineralization at the Cordero deposit.

mentioned faults, it controls the orebodies on the northeast side of the mine from the No. 5 level to the No. 2 level. The amount of ore found above this fault zone has not been significant.

CORDERO OREBODY

Minor faults and/or fractures appear to control and localize the cinnabar mineralization along M-fault. The strike of most of these so-called "slips" fall within a range of ten degrees to each of three main directions. One group of slips is parallel to M-fault (N45°E); another is a north-south grouping; the last group strikes east-west. Their dips vary but the most common angle is about 45°. These slips, which disappear at depth, steepen as they approach M-fault and feather out at their lateral extremities. They are usually associated with clay gouge and slickensides, and often have concave and convex surfaces. Some of these slips are so intermingled with lenses and wedges that they actually form "slip zones" to which the breccias are closely associated. These slips become less numerous in the hanging wall and laterally away from the main orebody.

The Cordero orebody itself extends from just above No. 3 level down to No. 8 level. In plan, it is almost 250 ft long and 50 ft wide with the long axis oriented parallel to M-fault. In this zone, the ore-bearing slips are in close enough proximity to each other so that the orebody will average 10 lbs of mercury per ton.

Away from the main ore zone, the orebodies are small pockets or lenses that appear to be offshoots of the main body. These smaller orebodies generally are inclined toward the main cinnabar deposit. Each individual lense is controlled by one or more slips, and these bodies plunge vertically in the plane of the controlling slip. However, the next nearest orebody will most often be found either at a lower elevation closer to the main orebody or at a higher elevation farther away from that zone.

The main ore zone and the subsidiary offshoots have a nearly common top located between the No. 3 and No. 4 levels, about 250 ft below the surface. Ore above this level is insignificant when compared to that lying below. The small mass of opalite overlying the main orebody only extends downward about 100 ft. As such, the 150-ft difference between the bottom of the opalite and the top of the main orebody throws serious doubt on any theory of "cap rock" control at this deposit.

SEQUENCE OF MINERALIZATION

Briefly, the first significant event was the faulting which brought the footwall rhyolite into fault contact with the Cordero rhyolite and developed the various minor fractures and faulting in the hanging wall. In a subsequent series of overlapping periods of mineralization (Fig. 4) during late Miocene, the Cordero rhyolite was subjected to hydrothermal solutions with consequent argillic alteration at depth and silicification at or near the present surface. Since the extremely altered areas at depth do not contain ore and the opalite did not contain ore until brecciated, it is assumed that most of the alteration and silicification was prior to the deposition of cinnabar.

Marcasite was then introduced over many square miles at both Cordero and Bretz mines. This mineralization did not respect either footwall or hanging wall for minor amounts of marcasite are quite evident in the footwall rhyolite on the lower levels of the mine. It has been determined that the major period of cinnabar deposition followed the marcasite, and it was in turn followed by quartz and barite mineralization respectively. Within the orebody itself marcasite assays 2%; cinnabar, 0.6%; late quartz, 0.05%; and barite, 0.01%. Native mercury as well as oxychloride stains have been found in the mine and surrounding area, and the oxidation of the marcasite, now proceeding at an artificially accelerated rate, has produced a great amount of ferric and ferrous sulfates, such as melanterite, fibroferrite and copiapite.

EXPLORATION DRILLING METHODS AT CORDERO

Surface drilling at Cordero consists of churn drilling 6-in. diam holes to depths up to 500 ft. A sample is bailed out every five feet for panning and assaying. The normal patterns are skewed rectangles for area exploration drilling, and parallel perpendicular lines for structure drilling along assumed faults. This latter pattern has proved effective as shown by the recent discovery of the Corderito orebody, situated along Harper fault. Cost of churn drilling is about $2.00 per ft within approximately one mile of the mine shop.

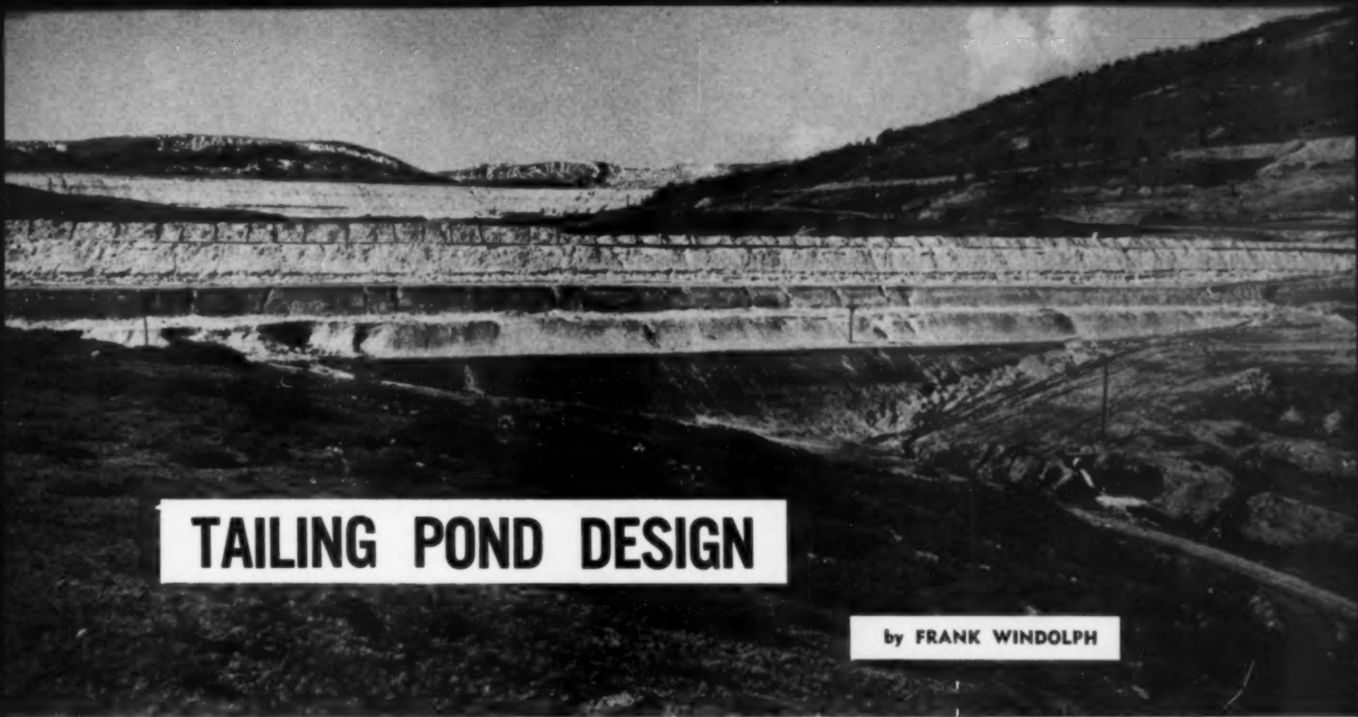
Underground exploratory drilling was first done by rotary diamond drilling. In the upper oxidized zone it worked well, but in the deeper zones of alteration, the marcasite and clay combined to slow the drilling and increase the bit cost.

Meanwhile, for short near-horizontal holes, air-leg drilling with sectional steel was utilized and sludge samples were taken every 5 ft. Holes up to 60 ft in depth were drilled and are still being drilled to explore the host rock from the present square set stopes.

In the fall of 1959, the company purchased a 3½-in. drifter on a 6-ft, deep hole, aluminum shell with a 3½-in. diam air bar which has proved to be very satisfactory. In the highly altered material, the deepest down-hole drilled thus far has been 84 ft and the deepest up-hole has been 126 ft, both at a cost less than $1.00 per ft.

SUMMARY

It can now be said that the grade and configuration of the ore encountered at depth are such that the Cordero mine will be worked out with little or no ore remaining that will assay more than 3 lbs of mercury per ton of ore. Present geologic knowledge and theory have given probable locations of future orebodies and extensions of presently known orebodies which even today at the presently reduced price of mercury can be economically explored by the low cost drilling system which is now being used.



TAILING POND DESIGN

by FRANK WINDOLPH

There are no hard and fast rules for building tailing dams, and each case has to be analyzed individually because of special conditions encountered at each location. Certain criteria are used for building dams at Climax, Colo., where they must be placed in rather steep mountain valleys on foundations that are practically impermeable. The tailing is relatively coarse, and a coarse fraction stays near the berm where it is deposited, while most of the fines flow with the water to the pool. Thirty years experience has led to certain design for toe dams, decanter lines and towers and tailing dams.

A new tailing disposal area, started at Climax in 1958, will ultimately have a height of 495 ft and impound about 300 million tons. The following applies to the construction of this new tailing area.

TOE DAM

The earthen toe dam which impounds the initial tailing is the key to the stability of the tailing dam; the toe was placed where proper foundation materials existed. Stability of the soils was investigated and evaluated under the earthen toe dam and along the toe of the tailing above the earthen dam. The peat bogs which ranged up to 8 ft deep were removed and the soils were investigated to insure that these materials would develop ample friction and be stable and relatively incompressible when subjected to superimposed weight. The bottom of the valley consisted of heterogeneous alluvial and slope wash deposits, and the area under the earthen toe dam was excavated deep enough to get below the seams of fine sands and silts that were encountered near the surface.

The earthen toe dam was constructed of good fill material which was relatively impervious, and a blanket rock filter 8 ft wide and 3 ft deep was placed on the bottom of the downstream side to prevent uncontrolled seepage from the dam face.

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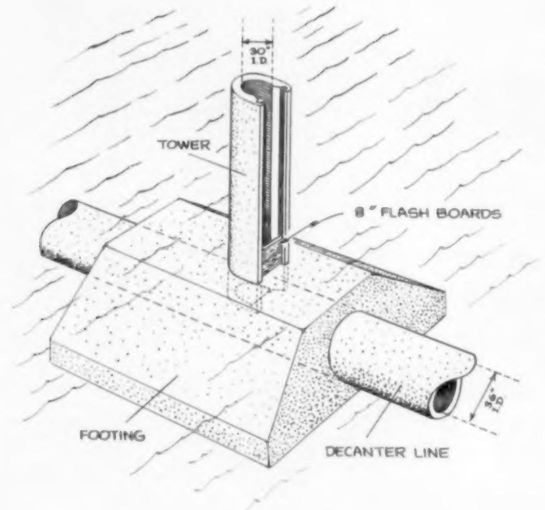
The height of the earthen dam was 35 ft, which was the minimum to permit economical operation in the initial dam building stages. The top of the toe dam was 450 ft in length. The tailing was deposited at the rate of 5000 tpd intermittently during the start-up stage. The downstream slope of the toe dam was 2½:1 and was considered sufficient to insure the stability of the structure.

A system of underdrainage was installed under the dam and extending upstream from it. The system contained six lines of perforated pipe 12 in. in diam spaced about 100 ft apart and extending under the dam and upstream 500 to 600 ft. Each pipe was laid with perforations down on a bed of sand in the bottom of a trench 3 ft wide and about 6 to 8 ft deep. The trench beside and over the pipe to a depth of 2 ft was filled with small gravel between about ¾ in. and No. 4 sieve size. The ditch was then filled with coarse tailing of the grain size of fine sand, and a blanket of the coarse tailing from 1 to 3 ft deep was placed over the entire area behind the toe dam to provide an effective filter bed. The same type of drains will be installed uphill along the toe of the tailing. The purpose of the drainage system is to lower the water table near the face of the dam to increase dam stability and prevent seepage.

In addition to providing for decanted water, it is necessary to accommodate large quantities of spring run-off from the mountain stream beds of Colorado. A decanter line 42 in. in diam was installed in the toe dam, and two decanting towers of adequate size to handle 100 cfs of spring run-off or possible flash floods were placed on the line. The initial decanter line was of low strength and expendable and the main line was installed uphill in more suitable soil. The two decanting towers were necessary in the early stages to permit the removal of clear water because of the slope of the terrain upstream from the toe dam. Concrete cutoff walls were installed on all decanter lines and drain pipes to prevent erosion along the pipes.



Decanting tower: Vertical monolithic concrete standpipes with vertical-slotted openings where concrete flash boards are placed to maintain the proper water level.

DECANTER LINES AND DECANTING TOWERS

Tailing dams have been built to a height of over 200 ft at Climax and there are plans to build to 495 ft in the new tailing area. The greatest weakness in the tailing deposits is the decanter lines.

The early lines were of extra-strength concrete and 3⅜ in. thick in the 36 in. diam size. These lines were buried and backfilled with coarse grained filler material which was tamped in place. Several of these lines have failed when the tailing load reached about 100 ft.

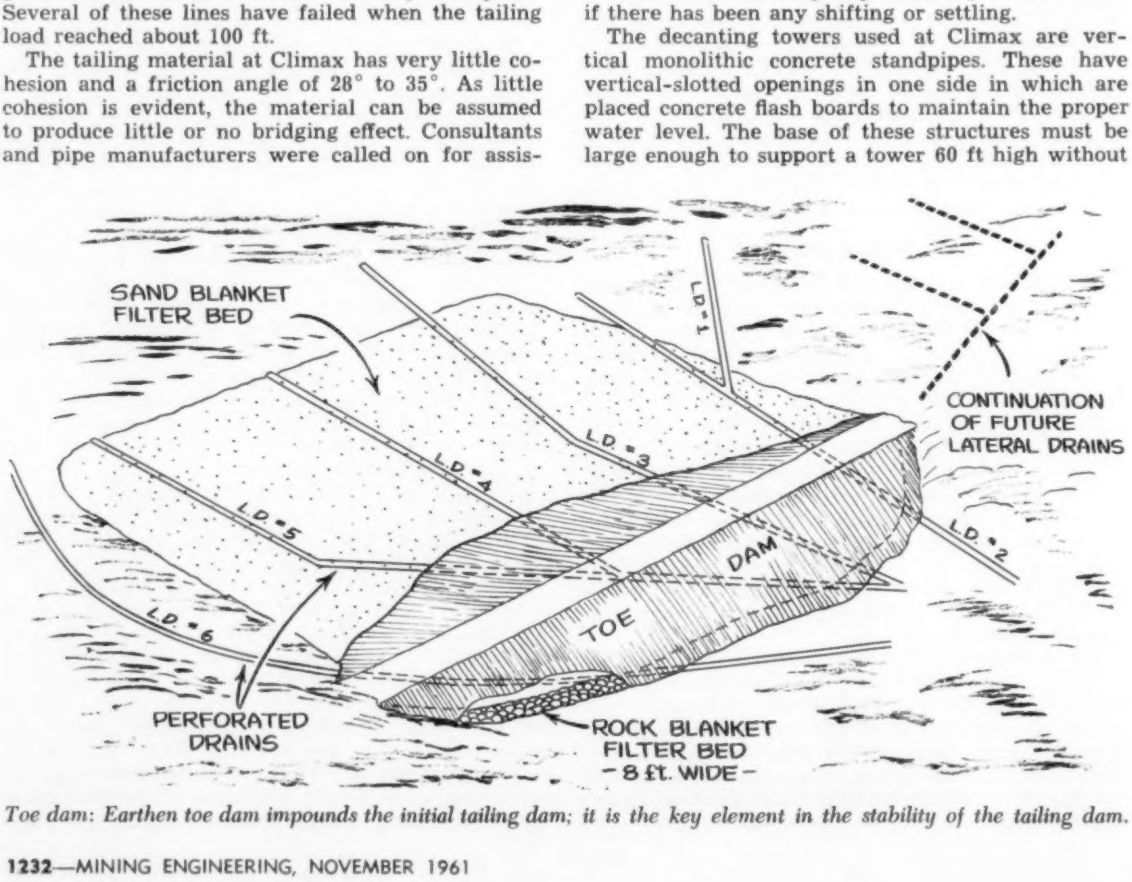
The tailing material at Climax has very little cohesion and a friction angle of 28° to 35°. As little cohesion is evident, the material can be assumed to produce little or no bridging effect. Consultants and pipe manufacturers were called on for assistance in designing 36 in. diam pipe suitable for the conditions. The final design for concrete pipe to be subjected to the greatest load of tailing was 7½ in. in wall thickness of 5000 psi concrete, 4-0 cold drawn steel wire spaced at 2 in. around the circumference of the pipe and segments of 4-0 wire placed at the top, sides and the bottom for extra strength. Shear bars were also placed between the two cages of reinforcing wire. Compressive tests were made on 2-ft sections of this pipe and the pipe withstood 70,000 lb per lineal foot before starting to fail in diagonal tension. The design load was approximately 64,000 lb per lineal foot. This special pipe was fabricated in 8-ft lengths and thoroughly inspected before installation. The design was probably conservative as some equalizing pressures will be realized from the backfill, but successful performance of the conduits justified the design.

The pipe was also fitted with a Stanton-Cornelius "O" ring joint to make the pipe watertight. The watertight joints are desirable to prevent water from passing through the joints, particularly from the outside in, which would carry tailing by erosion and cause bedding failure and other difficulties.

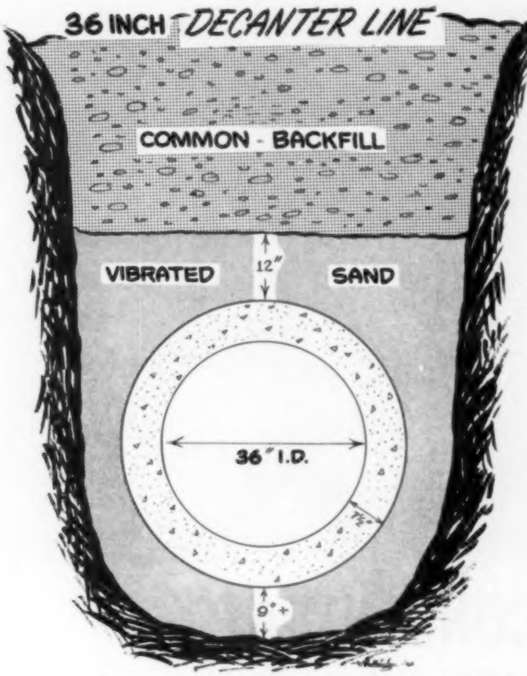
The pipe was installed in a trench with a minimum bedding of 9 in. of vibrated concrete sand under the pipe and a foot of the sand over the pipe. The trench excavated for the pipe was held to a minimum depth of two pipe diameters. Where bedrock was encountered, the rock was overexcavated for a depth equal to the pipe diameter and filled with the slightly compressible local material. Concrete cutoff walls were provided at critical points to prevent piping along the line.

The large decanter pipes at Climax can be inspected for stress cracks and other signs of failure. These lines are surveyed periodically to determine if there has been any shifting or settling.

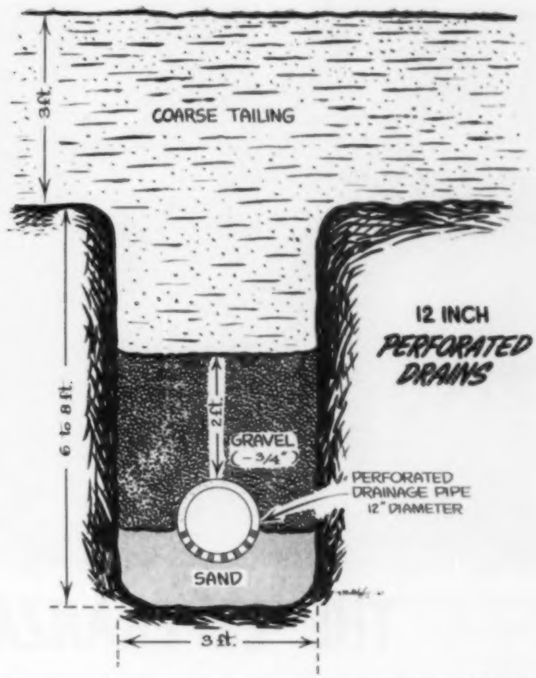
The decanting towers used at Climax are vertical monolithic concrete standpipes. These have vertical-slotted openings in one side in which are placed concrete flash boards to maintain the proper water level. The base of these structures must be large enough to support a tower 60 ft high without



Toe dam: Earthen toe dam impounds the initial tailing dam; it is the key element in the stability of the tailing dam.



Decanter lines: A 36-in. diam pipe was installed in a trench with a minimum bedding of 9 in. of vibrated concrete sand under the pipe and 1 ft of sand over the pipe.



Drainage: An underdrainage system installed under the earthen toe dam contains six lines of perforated pipe 12 in. in diam which extends upstream about 500 to 600 ft.

settling, and we can expect little vertical support from the tailing around the towers because the material is almost cohesionless.

High strength towers are necessary because of the severe conditions at Climax such as a block of ice floating into a tower in the spring of the year.

Each tower has a discharge opening 30 in. in diam and will handle 60 cfs of water with 10 ft of head and 80 cfs with 23 ft of total head above the invert. The high flow capacity is necessary to handle the spring run-off.

TAILING DAMS

Climax tailing is relatively coarse and, when deposited, forms a slope of about 0.9%. The majority of the fines flow to the water pool and the coarse material with good drainage characteristics is deposited on the shore.

The slope of the faces of the present tailing dam is about 3:1, and on the new tailing pond the tailing will be given a slope of 4:1 until a height of 100 ft is reached; thereafter the slope will rise at 3:1. The flat slope in the lower 100 ft is desirable to reduce shearing stresses in the soil below the toe of the dam. This will increase the stability of the deposit and decrease the tendency of the foundation material to spread and to elongate the various pipes buried in it.

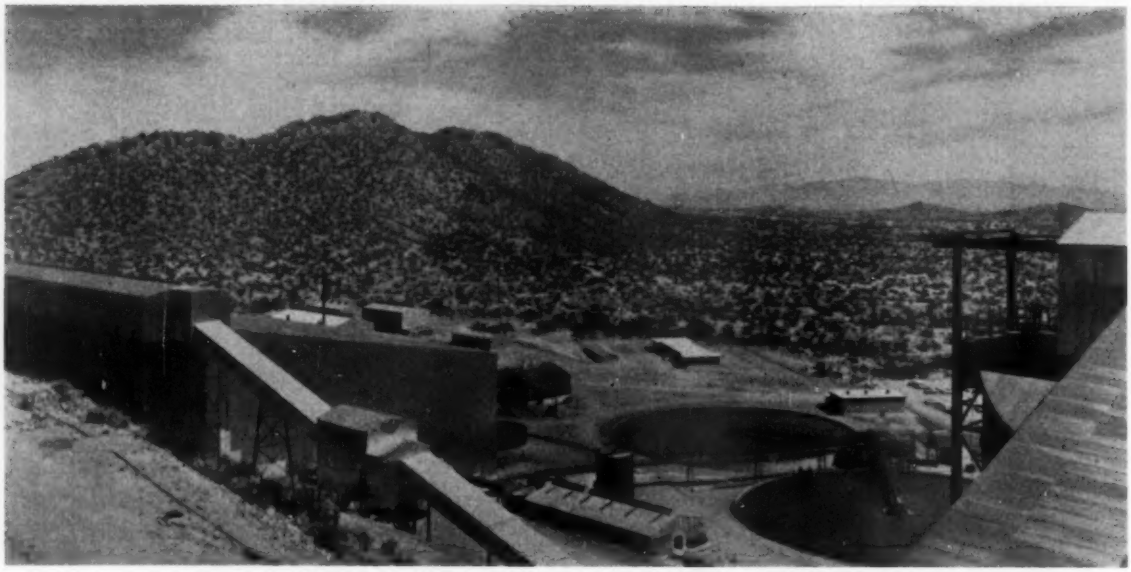
Soil tests have been made periodically on the present tailing pond to determine the stability, and the same will be true of the new tailing pond to make sure that the dam is safe against failure from liquefaction or sliding along some surface of minimum strength. The soil studies include the character, relative density, strength and compressibility of the foundation materials. The most important physical property of the tailing in connection with spontaneous liquefaction is looseness, which is indicated by relative density obtained by standard penetration tests in borings or by volume and weight of undisturbed samples from test pits.

The water table is logged through 3-in. piezometer holes and infers the porewater pressure near the bottom of the deposit. All of the stability studies indicate strongly that if the material in the bank is draining well, no trouble will be encountered. The strength of the tailing is adequate if dry, but weakness occurs if the tailing is wet; anything that can be done to improve the drainage near the faces is the best measure of insurance. If the water table did rise to a level that was thought to be dangerous, pumping from wells would be tried to reduce the water table.

As mentioned earlier, it is believed that the most serious aspect of the stability of the deposits is the possibility of rapid erosion from the failure of buried pipelines. Next in order is the drainage characteristics near the face. The design work is aimed squarely at these two problems.

Constant vigilance is necessary in all the details of tailing deposits, and is most important in day-to-day operation. Signs of erosion, increase in dampness or any other unusual developments must be investigated until the implications are understood. The piezometric devices should be maintained and observed regularly. Another cardinal rule is to keep the water as far from the crest as possible to prevent overtopping and still have enough pool area to adequately settle the solids. The tailing area must be large enough so that the tailing is not deposited too long in any one location. The water table always rises when dumping in the close vicinity of a piezometric hole and recedes when the deposition is elsewhere.

[Special acknowledgment is extended to E. J. Duggan who has contributed so liberally to tailing pond practice and design.]



THE ESPERANZA CONCENTRATOR

After two years' experience, Duval Sulphur & Potash Co. discloses details of new automated flowsheet for copper and molybdenum.

by C. H. CURTIS

The Esperanza mine of the Copper Division of Duval Sulphur & Potash Co. is located in the Twin Buttes District, 32 miles southwest of Tucson, Ariz. Records of mining activity in this vicinity date back to the 1850's. The New Year's Eve mine, which was last active briefly during the years of World War II, made the first actual penetration into what is now Duval's Esperanza property.

Duval's exploration department became interested in the Esperanza in the fall of 1954. The first test hole was started on May 8, 1955. Two years of intensive exploration work together with metallurgical studies developed the basis for the decision to establish an operation.

An engineering and construction contract was awarded June 29, 1957, for the concentrator and related facilities. Pre-mining stripping operations began in November 1957. On March 1, 1959, actual production was under way.

The Esperanza ore is a typical disseminated porphyry with secondary enrichment chalcocite mineralization overlying a chalcopyrite primary zone with important molybdenite mineralization existing in both ore zones. Oxidation of the ore has occurred to a significant extent.

This article is a comprehensive survey of the milling operations of the Esperanza concentrator. To this end, detailed process flow diagrams are presented, together with a text, which points up the salient mechanical and metallurgical features of the plant.

CRUSHING

Conventional three-stage crushing is provided for by a 48-in. primary gyratory, followed by one 84-in. secondary crusher and two 84-in. tertiary crushers, operating in open circuit with vibrating screens.

An important feature of the crushing circuit is the use of crushers equipped with hydraulically supported mantles; specifically, a 48-74 gyratory crusher, a 17-84 cone crusher and two 5-84 cone crushers.

The hydraulic feature greatly facilitates the adjustment of crusher settings; in fact, the Duval installation design has provided for adjusting cone crusher settings while operating under load. In addition, these hydraulic crushers have been equipped with Duval-designed instrumentation and automatic controls. Thus, with the tertiary crusher settings adjusted to yield an acceptable product size, desired loading of tertiary crushers is maintained by instruments which vary the original feed rate to the secondary-tertiary crusher circuit. In addition, desired relative loading of two tertiary crushers operating in parallel is maintained by instrumentation. Concurrently, the secondary crusher loading is also controlled as desired by instruments which vary the mantle position and, therefore, the crusher setting. In this manner, the secondary-tertiary crusher circuit is subject to fully automatic control whereby, with the tertiary crushers set to yield the desired product size, each crusher in the circuit is operated at optimum capacity.

Crusher product passes over a load-cell type weight recorder and is delivered into a 20,000-ton live capacity fine ore bin by a continuously travelling tripper.

Dust control throughout the crusher operations, including the fine ore bin and attendant feeder belts to the wet grinding sections, is effected with multiple dust collecting units. Design capacity of the primary crusher circuit is 1400 tph, with that

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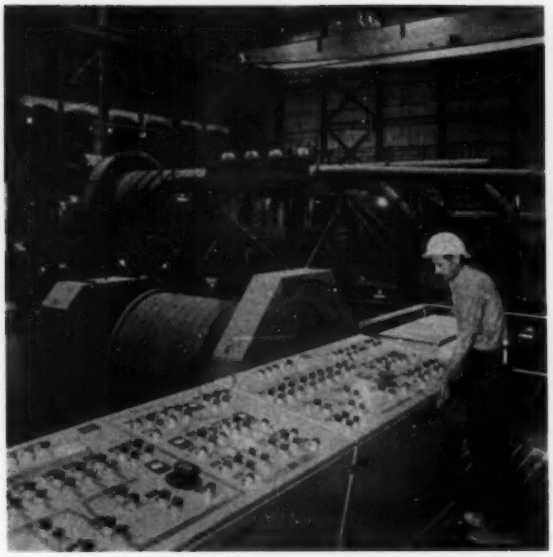


One of two completely independent wet grinding circuits consisting of a rod mill in open circuit with discharge split to two ball mills. Control center in foreground.

Overlooking flotation bay, cleaner flotation for one of two sections in left foreground with rougher flotation in center. Office and instrument shop in background.

of the secondary-tertiary circuit at 1000 tph. This provides for two-shift operation, six days per week, to supply the grinding-flotation circuit schedule at 12,000 tpd, seven days per week.

WET GRINDING AND FLOTATION

Wet grinding and flotation operations are conducted in two mill sections that are essentially metallurgically independent, each with separate reclaimed water systems, and each producing its own final concentrate and tailing. Thus, competitive plant scale metallurgical testing can be conducted at will.

Each grinding section consists of one rod mill in open circuit with discharge split to two ball mills, operating in closed circuit with cyclone classifiers. All grinding mills are 12.5 ft diam inside the shell, with the rod mill 16 ft long, and ball mills 14 ft long. The rod mill reduces a 10% plus ¾-in. feed to a 10% plus 10-mesh product, which is further reduced in the ball mill-cyclone closed circuit to a 10% plus 65-mesh product at 33% solids for flotation feed.

Feed to the wet grinding section to date has been manually controlled. However, instrumentation provides for automatic control of the original feed rate to maintain desired circulating sand load on the ball mills, and experimentation with the fully automatic system is currently in progress. Total water addition to the grinding circuits, which includes the flotation middlings return, is controlled by instrumentation to maintain desired pulp density in the ground product, which is the flotation feed. Distribution of total water within the grinding circuit is regulated by instruments for desired pulp density control in rod and ball mills.

Alkalinity (normally in the high pH range above 11.5) for flotation feed is automatically maintained by instrument-controlled lime addition to the grinding circuit.

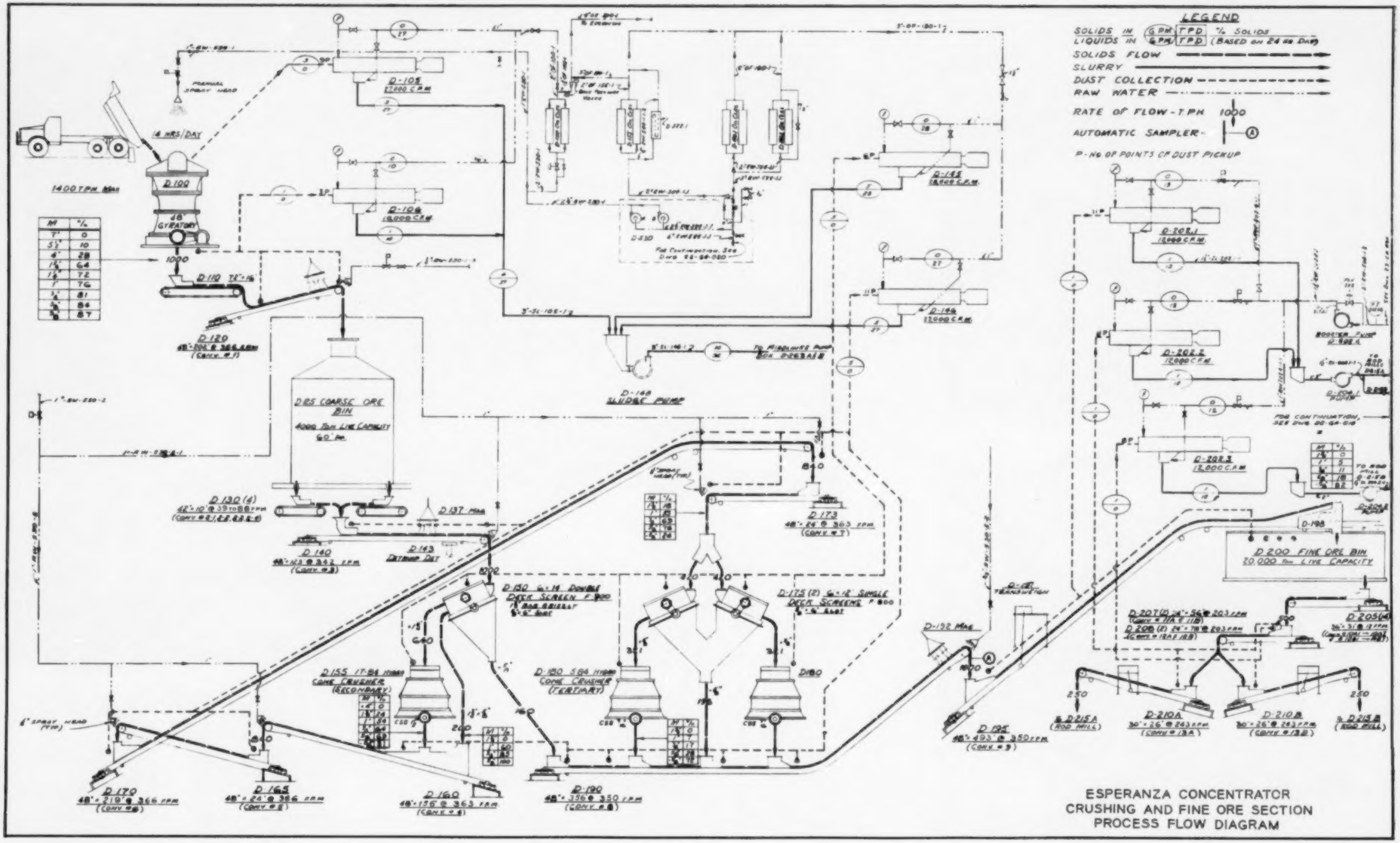
The two flotation sections are equipped with 48-in. mechanical cells having double froth overflows and froth paddles. Roughers are arranged in rows of ten cells each with step-down transitions providing independent pulp levels for the first two cells, the next four cells, and the final four cells of each row. Instrumentation provides automatic control of these pulp levels. There are nine parallel rows of roughers in each section which furnish approximately 5.5 min flotation time at design capacity (12,000 tpd).

Flotation reagents to date have consisted of potassium ethyl and amyl xanthate as collectors, together with stove oil as molybdenite promoter. Methyl amyl alcohol has been the frother. Reagents are fed by Flowrators located on instrument panels established at the flotation control centers for each section. Instruments provide a continuous and permanent record of the reagent flows.

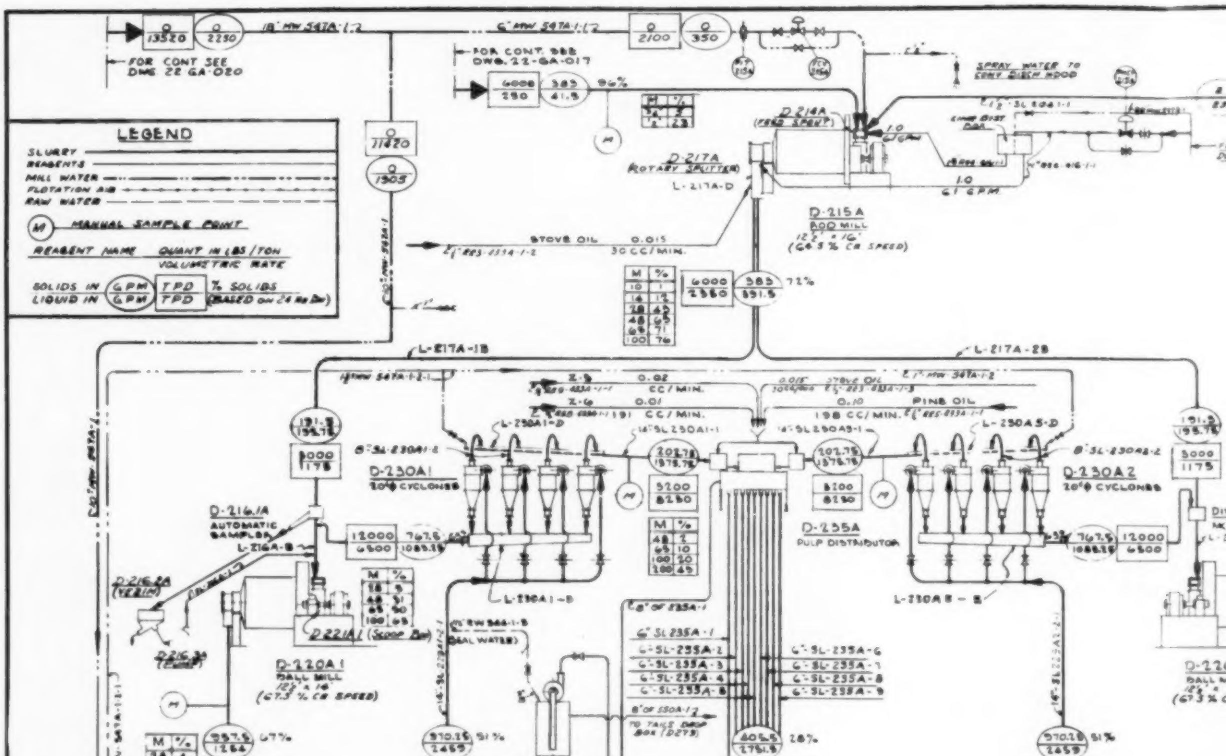
WATER RECLAMATION AND SUPPLY

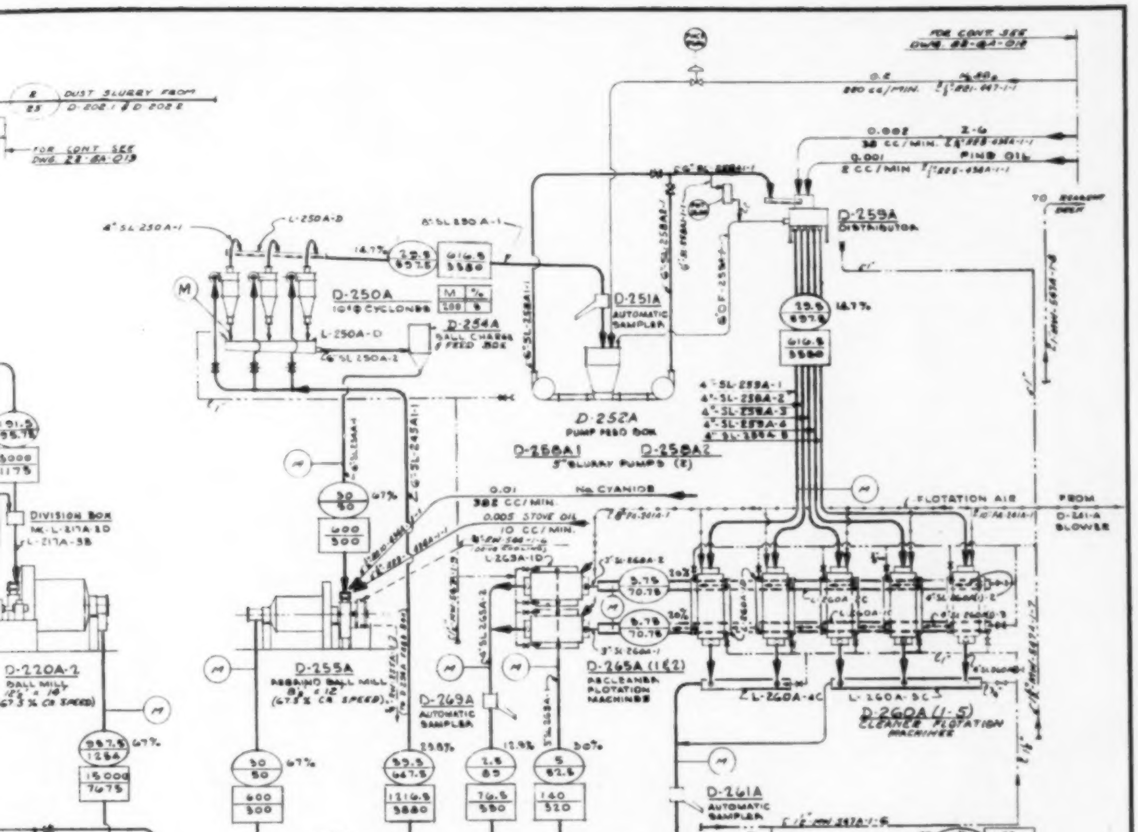
Rougher flotation tailing is the flanl plant tailing and it is flowed to two 225-ft diam traction thickeners, each preceded by a 26-ft diam hydroseparator. The hydroseparator spigot discharges are equipped with pressurized rubber control valves. The thickeners are instrumented for automatic underflow control. Fresh water makeup to the mill circuits is added to the tailing thickeners to utilize the excess lime alkalinity of the tailing for alkalizing the new raw water.

Combined underflows of the hydroseparators and thickeners are flowed by gravity through 16-in. O.D., 14-gauge, welded steel pipe, with a ½-in. thick cement lining, to the tailing storage area. This line closely follows the natural ground contour, and includes one major dip or so-called inverted syphon. "Drop boxes" are provided, where necessary, to limit the line gradient to 0.8% to the actual tailing storage area, within which the line is maintained horizontally. The tailing dam is developed by throwing up an 8-ft berm with a dragline, followed by sand fill in front of the berm with cyclone classifiers set at 72-ft intervals along the top of the berm. Cyclone overflow material is released 40 ft in front of the berm. After this sand-

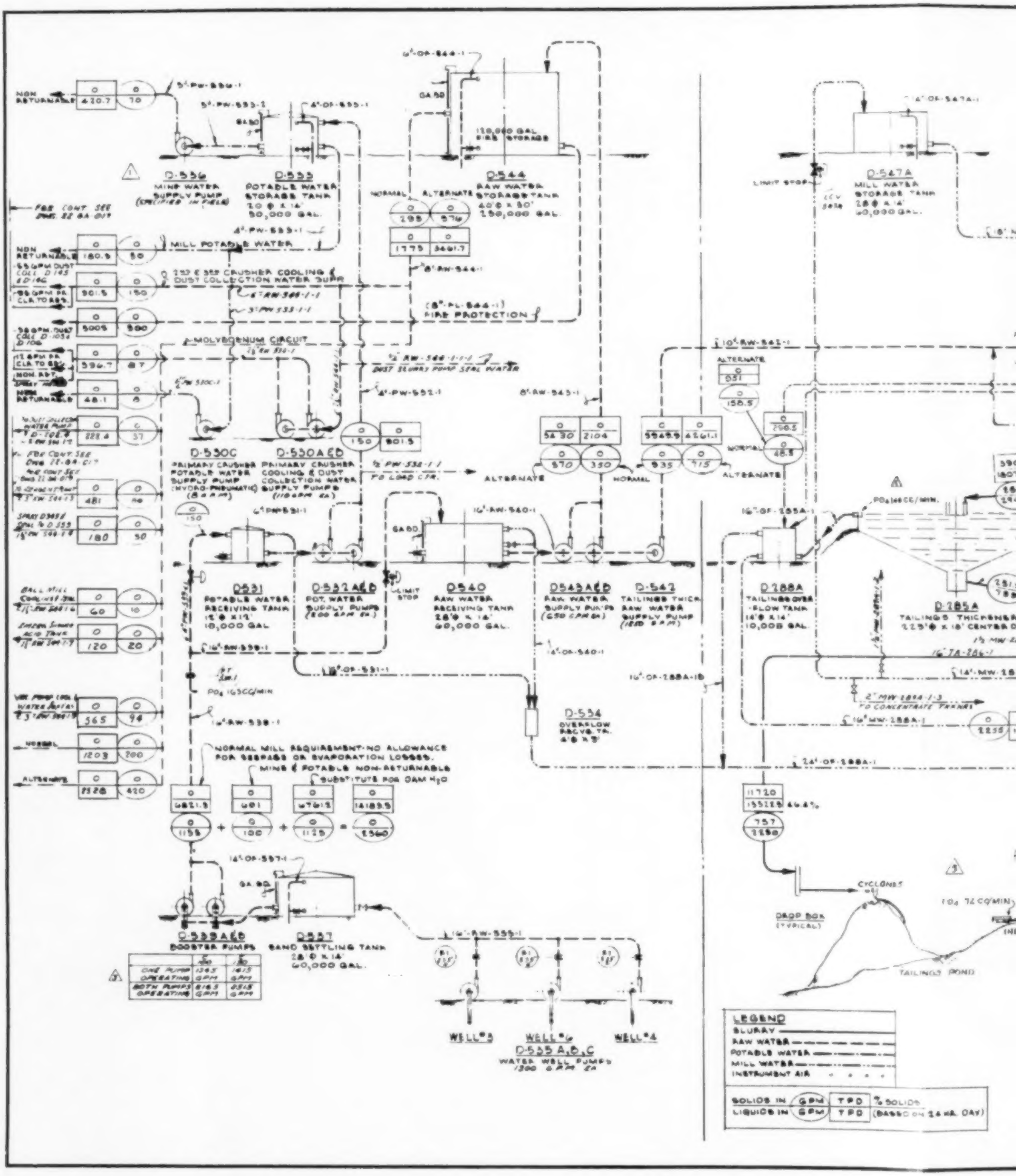


ESPERANZA CONCENTRATOR
CRUSHING AND FINE ORE SECTION
PROCESS FLOW DIAGRAM

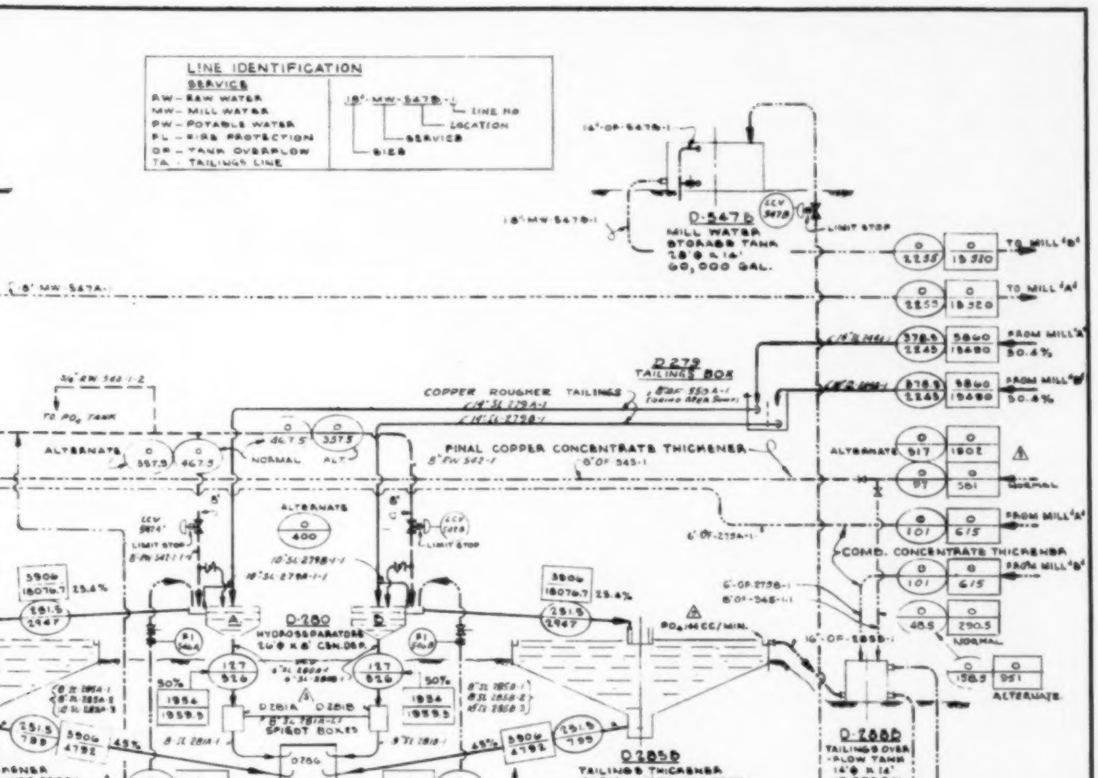

LEGEND
SLURRY
REAGENTS
MILL WATER
FLOTATION AIR
RAW WATER
MANUAL SAMPLE POINT
D-215A
ROD MILL
D-217A
ROTARY SPLITTER
D-230A1
D-230A2
D-235A
PULP DISTRIBUTOR
D-220A1
BALL MILL
D-227A
WEIR BOX
D-240A (1-9)
ROUGHER FLOTATION MACHINES
D-241A
BLOWER
D-244.1A
AUTOMATIC SAMPLER



ESPERANZA CONCENTRATOR
CONCENTRATOR SECTION "A"
PROCESS FLOW DIAGRAM



D-536
MINE WATER SUPPLY PUMP
D-533
POTABLE WATER STORAGE TANK
50,000 GAL.
D-544
RAW WATER STORAGE TANK
250,000 GAL.
120,000 GAL FIRE STORAGE
NORMAL
ALTERNATE
MILL POTABLE WATER
FIRE PROTECTION
MOLYBDENUM CIRCUIT
DUST SLURRY PUMP SEAL WATER
D-530C
PRIMARY CRUSHER POTABLE WATER SUPPLY PUMP (HYDRO-PNEUMATIC)
D-530A&B
PRIMARY CRUSHER COOLING & DUST COLLECTION WATER SUPPLY PUMPS
TO LOAD CTR.
D-531
POTABLE WATER RECEIVING TANK
10,000 GAL
D-532A&B
POT. WATER SUPPLY PUMPS
LIMIT STOP
D-540
RAW WATER RECEIVING TANK
60,000 GAL.
D-545A&B
RAW WATER SUPPLY PUMPS
D-542
TAILINGS THICK. RAW WATER SUPPLY PUMP
D-534
OVERFLOW RECVG. TK.
NORMAL MILL REQUIREMENT-NO ALLOWANCE FOR SEEPAGE OR EVAPORATION LOSSES.
MINE & POTABLE NON-RETURNABLE
SUBSTITUTE FOR DAM H_2O
D-538A&B
BOOSTER PUMPS
ONE PUMP OPERATING
BOTH PUMPS OPERATING
D-537
SAND SETTLING TANK
60,000 GAL.
WELL #5
WELL #6
WELL #4
D-535 A,B,C
WATER WELL PUMPS
NON RETURNABLE
ALTERNATE
D-547A
MILL WATER STORAGE TANK
60,000 GAL.
LIMIT STOP
D-288A
TAILINGS OVERFLOW TANK
10,000 GAL.
D-285A
TAILINGS THICKENER
TO CONCENTRATE TANKS
CYCLONES
DROP BOX (TYPICAL)
TAILINGS POND
LEGEND
SLURRY
RAW WATER
POTABLE WATER
MILL WATER
INSTRUMENT AIR
SOLIDS IN GPM TPD % SOLIDS
LIQUIDS IN GPM TPD (BASED ON 24 HR. DAY)



ESPERANZA CONCENTRATOR
PLANT WATER SUPPLY & RECLAMATION SYSTEMS
FLOW DIAGRAM

Table I. Typical Metallurgical Data

Tons milled per operating day	12,000
Operating time, % of possible	95.0
Copper Recovery	
% of sulfide copper	92.0
% of acid-soluble copper	60.0
% of total copper	83.0
Molybdenum Recovery	
Primary recovery from ore	80.0
Secondary recovery from Cu-Mo concentrates	90.0
Overall recovery	72.0
GRADE COPPER CONCENTRATE	
% Cu	25.0
% Fe	25.0
% Insol	14.0
GRADE MOLYBDENUM TRIOXIDE CALCINE	
% MO	58,6
% MoO_3	88.0
% Cu	0.25
% Fe	2.5
% Insol	8.0
% S	0.25

Table II. Operating Statistics

Power Consumption	KWH/Ton
Crushing	1.4
Wet Grinding	12.8
Flotation	4.2
Water	0.9
Molybdenum Recovery	0.9
Total	20.2
Reagent Consumption	**Lbs/Ton Ore**
Lime	3.5
Potassium ethyl xanthate	0.025
Potassium amyl xanthate	0.005
Methyl amyl alcohol	0.10
Stove oil	0.03
Sodium ferrocyanide	0.05
Manpower (hourly paid)	**Tons/man-shift**
Operating	237
Maintenance	249
Operating & Maintenance	126

ing phase of tailing deposition is completed, the tailing is released without classification at high volume flow rates. This keeps solids in suspension during transportation at minimum ultimate flow gradient, and thus maximizes the storage per vertical foot of dam height. Water reclamation from the tailing storage area is planned with a pump on skids with floating suction hose at a favorable collection zone, according to the natural contour of the original ground. Water is to be directed toward this zone by judicious scheduling of the points at which tailing is released into the area.

All rougher flotation concentrates are advanced for upgrading. They are initially cyclone-classified, with the cyclone underflow material sent to 8½ x 12-ft regrind ball mills, one in each section. The cyclone overflow, substantially all −200 mesh, is pumped to distributors ahead of five parallel rows of cleaners on each section. Each cleaner row consists of four cells, with finished concentrate produced on the first two cells, while the concentrate from the last two is advanced for recleaning in two parallel rows of two cells each. Recleaner rejects are returned to the cleaner feed. The cleaner rejects are returned to the primary grinding circuit as part of the integrated and automatically controlled dilution water.

The final copper-molybdenum concentrates are flowed to a 50-ft diam thickener in each section. Thickener underflows are serviced by diaphragm pumps and combined underflows advanced to the molybdenum recovery plant.

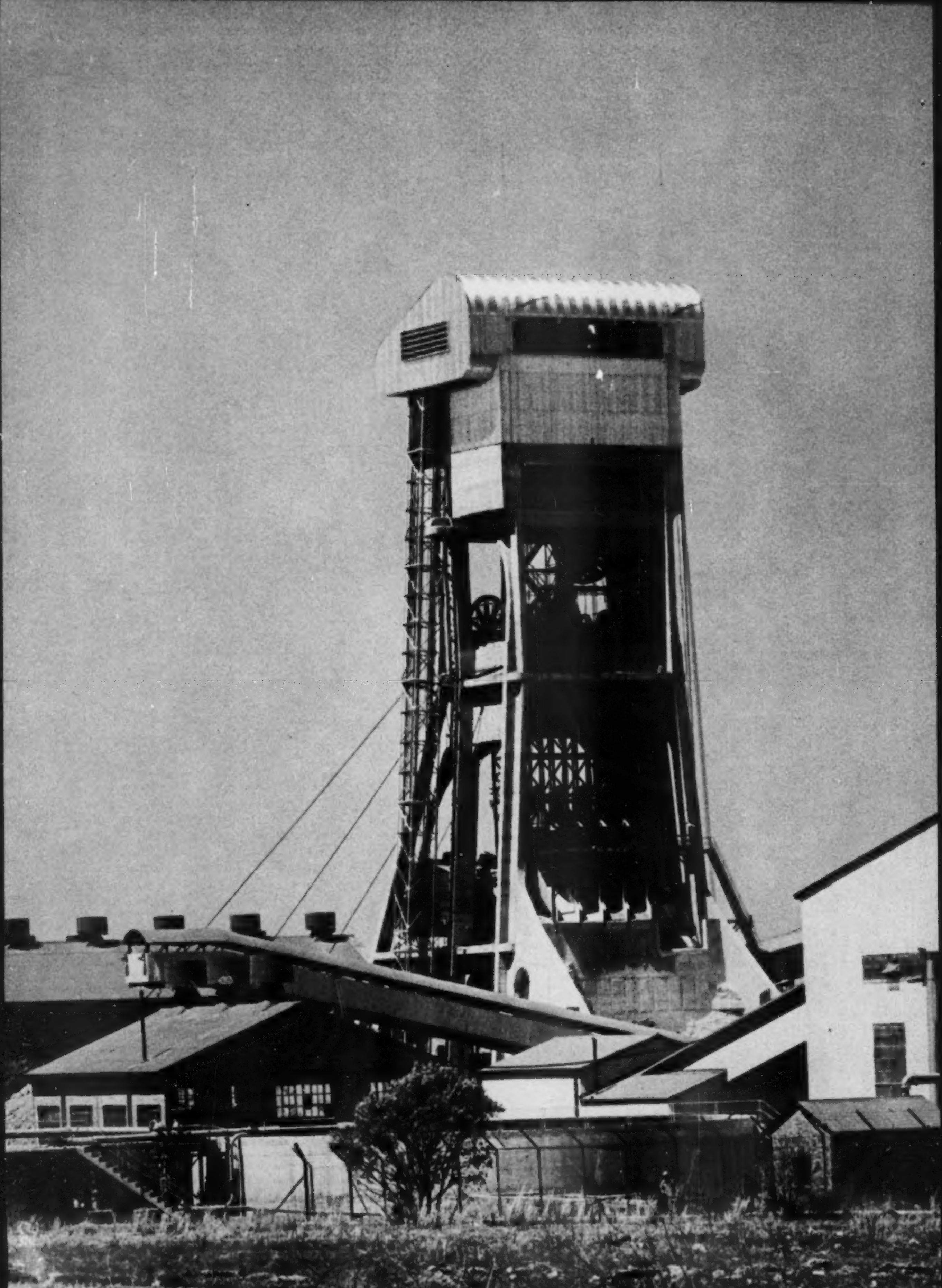
MOLYBDENUM RECOVERY

The molybdenum circuit provides for direct steaming and heating of thickened copper-molybdenum concentrates. Heat exchangers provide for transfer of heat from the hot pulp leaving the steamer to preheat cold pulp approaching the steamer. Use of ferro-cyanide is provided for in the flotation steps following steaming to further depress minerals other than molybdenite. In addition, a four-hearth furnace is available for drying and heating an intermediate molybdenite flotation concentrate if certain minerals other than molybdenite fail to respond to the depressing effects of steaming and ferrocyanide. To date, operation of this furnace has not been necessary. Extensive instrumentation provides for automatic control of the steaming operation, together with automatic pH control of the flotation phase of the operation.

Molybdenite rougher flotation consists of a twelve-cell row of 48-in. machines having double froth overflows and equipped with froth paddles. Stepdown transition boxes following each run of four cells provide three independent pulp levels in the row, subject to automatic control. Design retention time in the rougher is ten minutes. Rejects are flowed to one 60-ft thickener, the underflow from which is filtered on an 8½-ft diam, 7-disc filter. Cake is conveyed to a storage area from which it is loaded by front-end loader into 20-ton trucks and hauled to the railroad siding 11 miles from the plant for shipment to the smelter.

All molybdenite rougher flotation concentrate is advanced to a 40-ft diam thickener, the underflow from which is cycloned in closed circuit with a 5 x 6-ft ball mill. The cyclone overflow is pumped to the head of a ten-cell bank of 32-in. flotation machines. Cleaner rejects are returned to the concentrate thickeners feeding the molybdenite circuit. All of the cleaner concentrate is advanced to the No. 5 cell of a ten-cell bank of 28-in. flotation machines. Five recleanings are provided as the concentrates advance to the No. 1 cell in the row, which produces final molybdenite concentrate. Recleaner rejects are returned to the regrind circuit ahead of the cleaner as part of the dilution requirement.

Molybdenite concentrate is stored in a surge tank from which a metered flow is filtered by a 3-ft diam by 2-ft face drum filter. Filter cake is advanced to 8¾-ft I.D., ten-hearth roaster. The roasting furnace is completely instrumented, including push button lighting of pilots and burners with automatic flame-out protection, temperature recorder controllers, draft controllers, etc. Roasted calcine is further purified by leaching, filtering and washing, and is finally dried in a 4-ft I.D., four-hearth dryer. Automatic weighing and packaging facilities are provided for preparing the purified molybdenum trioxide calcine for shipment in steel drums containing 800 lbs calcine each, or cans containing 20 lbs equivalent molybdenum metal each.



◄ *Margaret shaft, Transvaal*

DESIGN OF CONCRETE HEADFRAMES FOR SOUTH AFRICAN GOLD MINES

by A. C. BACKEBERG

There is no South African code for the design of reinforced concrete headframes, and all those erected have been designed on a uniform basis which, up to the present, has tended to be conservative. With certain exceptions designs have generally conformed with British Standard Code of Practice C.P. 114.

In the design of reinforced concrete headframes the following loads are taken into account:

Dead load—These loads include the weight of: 1) the sheaves, platforms, beams and bearings; 2) the internal steelwork which is supported by the shell; and 3) weight of the structure itself.

Rope loads—For normal conditions, rope loads are taken as equal to the weight of the rope itself together with the weight of a fully-loaded or an empty conveyance, according to the circumstances. For extreme conditions, corresponding to an overwind in which the safety devices fail to operate, the force in a rope is assumed to be equal to its static breaking load.

Live loads—These loads include the weight of rock in any core bins which are incorporated in the structure, the reactions of conveyors supported by the headgear and the superimposed loading on the various working platforms.

Wind loads—These loads are usually based on a wind velocity of about 70 mph.

Two basic conditions of loading are considered in the design of reinforced concrete headgears. The first of these, which corresponds to the worst loading likely to occur under normal operating conditions, is the most adverse combination of: 1) dead load; 2) normal rope loads; 3) live loads; and 4) wind loads.

It is usual to specify that the stresses due to this combination of loading must not exceed the normal permissible stresses given in C.P.114, except that the 25% increase for the combined effects of wind and other loadings is not usually permitted.

The second loading condition, which represents the worst that is likely to happen in an overwind, is the most adverse combination of: 1) dead load; 2) breaking load of any one rope (alternative cases must be considered here—the first, corresponding to a conveyance jamming in the shaft; the second, corresponding to the case where a conveyance is arrested by the crash beams); 3) normal rope loads in all remaining ropes; 4) live loads; and 5) wind loads.

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For this combination of loads, it is usual to specify that the stresses may exceed the normal permissible stresses given in C.P.114 by 25%, provided the tensile stress in the reinforcement does not exceed 30,000 psi.

Where reinforced concrete headframes are used for shaft sinking as well as for normal operation, the loading conditions corresponding to both sinking and normal operation must be investigated.

The combination of loading corresponding to overwind conditions usually governs the design of a reinforced concrete headgear. Stresses due to ordinary operating loads, at least at critical sections, are checked by inspecting for tension in the concrete of the shell under the ordinary conditions of normal service.

MARGARET SHAFT—TRANSVAAL

When this headframe for a six-compartment rectangular shaft was being planned by the Stilfontein Gold Mining Co., structural steel was in such short supply that fabrication in steel had to be ruled out. The alternative was a concrete headframe, and suitable reinforcing steel was obtainable.

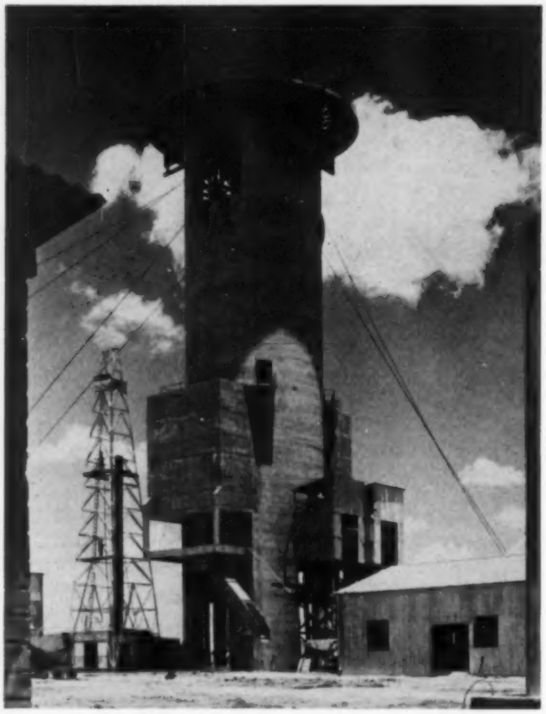
The loading conditions were given by the following data: height to sheaves—126½ ft; number of compartments—6; number and diameter of sheaves—six, 18-ft diam; hoisting ropes—2 in. diam, 200 tons breaking load; hoist load—610-ton skips at 5000 ft depth; rock reception—ore bin and waste bins to be provided; grouping of hoists—together.

In order to enable shaft sinking to commence and to continue while the construction proceeded, the design was required to make provisions for the support of six 8-ft diam temporary sinking sheaves at an elevation of about 48 ft above collar level.

The structure consists essentially of a rigid platform carrying the main sheaves at 126½ ft elevation supported by six legs which are framed together horizontally immediately below an elevation of 47¾ ft, where support is provided for the temporary sinking sheaves, as required. The legs are T-shaped in cross section.

The most adverse of the conditions of loading were taken for the design of the headgear, viz., one rope loaded to breaking point and the remaining ropes at normal full load simultaneously. To this load condition there was added an allowance of 20% for the effect of the actual breaking of the first rope and 60% was added to each of the other ropes to provide for loads due to acceleration.

Provision was also made for an upward thrust to deal with the kinetic energy to be absorbed in the event of an overwind, and cushioning devices



Riebeeck headframe of Loraine Gold Mines Ltd. in Orange Free State has a flat top for future Koepe hoist.

were incorporated in the headframe for this purpose.

The design was based on the following working stresses: concrete in beams—400 psi; main legs—625 psi; incline legs—750 psi; shear—150 psi; steel in tension—11,750 psi; compression—11,250 psi.

Extraordinary care was exercised in maintaining the concrete mix to the design requirements. Crushed dolerite was used, graded in a screening plant established on the site so as to ensure consistency of grading. The precaution was taken to dredge and stockpile the whole of the sand requirements from the Vaal River in a short space of time at the beginning of the contract so as to avoid the effects of seasonal change in sand grading. All concrete was vibrated, the mix being designed so that over-vibration could not arise.

The legs were poured in 6-ft lifts to the haunches of the beams; at this point the pour was monolithic, comprising a portion of the side and center beams and the stub of the leg. Concrete was cured by wrapping coconut matting around the members and keeping it constantly wet. Cube tests gave results varying from 4500 to plus 6400 psi, the average being 6000 psi after seven days. Cube moulds were vibrated with an external vibrator so that the results obtained gave a close approximation to the actual placing conditions on the site.

The lower portion of the headframe was completed within three months, after which the temporary sheaves were erected and concreting of the remainder of the structure proceeded.

Although provision had been made for the installation of three double-drum hoists to serve all six shaft compartments, only two hoists were purchased and installed initially. The ordering of the third hoist was deferred until conditions justified the further capital investment. A reassessment of the position in 1956 revealed that the greater output possible from a multi-rope Koepe hoist would be decidely advantageous. With this possibility in mind, the headgear design and foundations were carefully examined and the effect of placing the Koepe winder above the sheave wheel gantry was calculated. The investigation culminated in an approval of a Koepe winder installation which is now working at this shaft. The rock hoisted by the Koepe alone amounts to about 210,000 tons per month.

RIEBEECK SHAFT—ORANGE FREE STATE

When this shaft was sited, it was foreseen that there would be no escaping the problem of poor foundation conditions for a headframe.

The placing of foundations for a steel headframe at this site was complicated by the measures necessary to counteract periodical and changeable differential vertical movements through subsidence or heaving of individual foundations. The shaft was to have a 26 ft diam and 5745 ft hoisting depth. It was also to be divided with a brattice wall for ventilation requirements.

Two large, a-c, double-drum hoists were available, and they were to be situated on opposite sides of the shaft. These hoists are of 4400 hp at a speed of 3000 fpm, are fitted with 1⅞-in. diam ropes having a 175-ton breaking load that are capable of hoisting 8-ton skips or mancages for 90 men.

Provision was to be made in the design of headframe for a third large hoist which could be a tower Koepe hoist or, alternatively, a ground drum hoist fitted with ropes of 2⅛ in. diam and 230-ton breaking load.

The decision was taken to construct a circular reinforced concrete headframe 150 ft high, 35 ft internal diam and 18 in. wall thickness. It was also decided to sink the foundation to a depth of 60 ft. A caisson having a 3-ft thick wall was sunk accordingly and toed in at the bottom by spreading the width of the lining to a footing approximately 10 ft wide.

When this caisson was completed, the lining was cast to a 30-ft thickness by the normal hand-over-hand method for a further 38 ft of depth. This portion of the lining was reinforced, but below this point normal 12 in. thick unreinforced concrete shaft lining was used.

This structure depended for its stability partly on lateral passive pressures in the foundation in the direction of the maximum resultant pull of the winder ropes and partly on the eccentricity of foundation bearing pressure on a widened footing on the bottom of the 38-ft. O.D. cylinder. In calculating the passive pressure support, the contribution of material above the water table, which lay at 20 ft depth, was neglected.

The task of sinking the caisson was carried out in the accepted manner for successive lifts and, except for the extreme care necessary to maintain verticality by judicious control of the removal of spoil around the cutting edge, the procedure calls for no special comment.

The construction of the superstructure of the headframe was completed by the sliding shutter method and thereafter, when the full dead load of the structure was bearing on the caisson foundation, intimate contact with the cylinder and the sides of the excavation was achieved by soil-grouting through holes drilled in the cylinder.

GEOLOGIC STUDIES PLAY MAJOR ROLE AT HUDSON CEMENT CO.'S QUARRY

by JAMES R. DUNN

Planning quarry operations and control of the quality of rock materials at Hudson Cement Co. at East Kingston, N. Y., are special problems because of multiple uses for the stone and the great structural complexity of the rocks. Problems have been largely solved by detailed geologic work. These geologic studies have paid dividends in long and short range planning, in assessment of reserves, in vastly reduced cost of chemical analyses, and in reduced drilling costs.

Limestones of the Hudson Valley outcrop along the Hudson River from Albany to Kingston. Old established cement companies are located just south of Catskill and just east and southeast of Hudson, N. Y. The new Atlantic Cement plant is being constructed at Ravena. Hudson Cement located at East Kingston, is a newcomer and is closest to the New York metropolitan area (Plate I).

The limestones which are highest in calcium carbonate and which are the basis of the portland cement industry in the valley are the Manlius and Coeymans limestones (the lower cement series) and the Becraft and Alsen limestones (the upper cement series), all of Devonian age. These stones are blended in various ratios with stone above and/or below to approach the ideal portland cement raw mixes. Clay, bauxite or iron ore may be added.

Some of the limestones are also used as coarse aggregate for concrete. For instance, the Callanan Road Improvement Co. has large quarries for aggregate at Port Ewen on Roundout Creek and at South Bethlehem and is quarrying rock which is suitable for manufacture of both aggregate and portland cement. Agricultural lime, metallurgical grade limestone and natural cement are also produced in limited amounts from limestone in the Hudson Valley. Esopus shale (Devonian) is the basis of the new lightweight aggregate industry in the Kingston area. Hudson Cement now produces both portland cement and coarse aggregate for concrete from limestones on their property, and they are beginning production of lightweight aggregate from Esopus shale.

GEOLOGIC PROBLEMS IN QUARRYING

Quarrying limestone in the Hudson Valley has special problems because the limestones are heterogeneous in section. Nearly all aggregate and cement producers use more than one formation. (The extreme case is the Callanan Road Improvement Co.'s coarse aggregate quarry at Port Ewen which quarries ten different limestone formations.) Another difficulty is the structural complexity of the Devonian rocks of the valley. The most complex structures occur in the Callanan's quarry and at the Hudson Cement property.

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PLATE I

Cement and Stone Properties in the Central Hudson Valley of New York

Because of the stratigraphic and structural complexities, the systematic development and exploitation of rock which is expected to sire aggregate and cement materials of constant quality is rather difficult. Close coordination between the production of aggregate and portland cement materials is essential because of the intimate interrelationship of quarry operations.

The following approach has been evolved at Hudson Cement to cope with these conditions: 1) detailed geologic mapping, 2) drilling to test geologic structure, 3) detailed geologic description of cores, 4) reinterpretation of geologic structure, 5) a relatively few chemical analyses from carefully selected core intervals, 6) a method of graphic determination of stone composition which eliminates any need for drilling and chemical analyses ahead of operating faces.

GEOLOGIC MAPPING

The first step in evaluating reserve position was to make a detailed geologic map on a photogrammetrically prepared topographic map scale of 100 ft to the in. and 5-ft contour interval. The geologic map was made by identifying, plotting and describing virtually every bedrock outcrop on the property. Tentative cross sections were then drawn every 500 ft and preliminary determinations of quality of stone and reserves were made.

The geologic map and tentative cross sections were then made the basis of a drilling campaign to

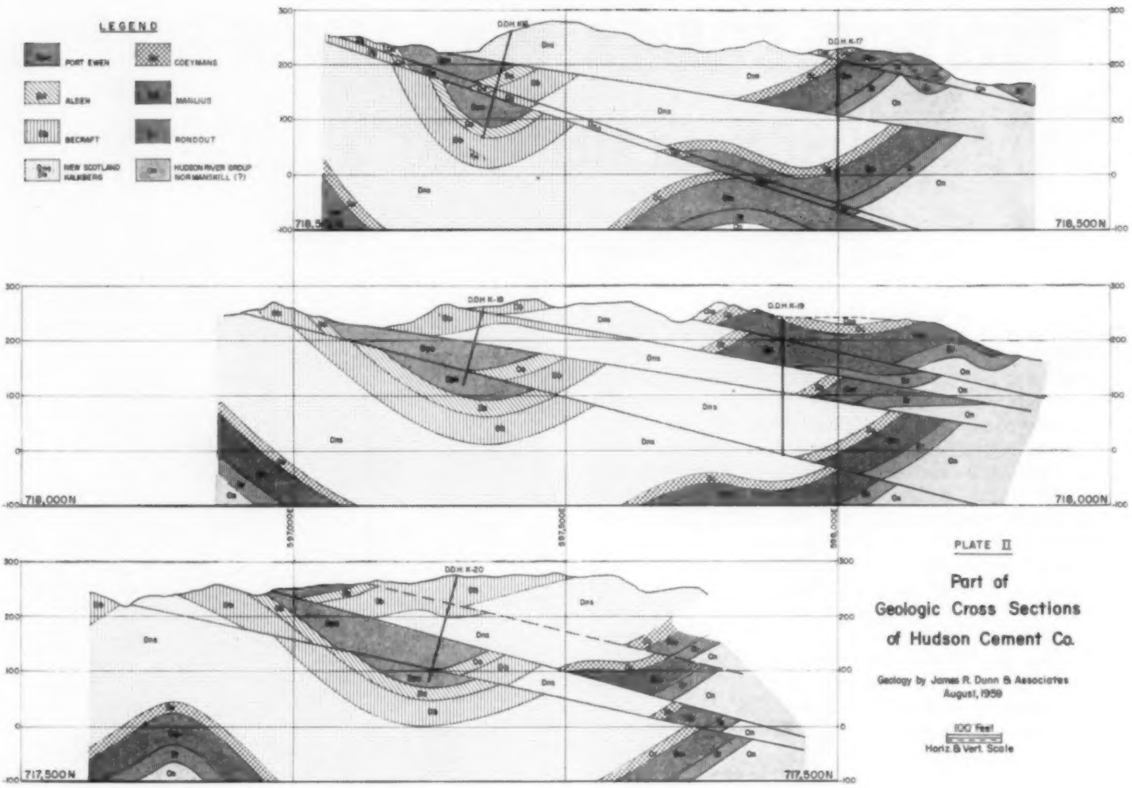


PLATE II

Part of Geologic Cross Sections of Hudson Cement Co.

Geology by James R. Dunn & Associates August, 1959

100 Feet

Horiz. & Vert. Scale

test further the structures and reserves. Drill holes for structural control averaged about 300 ft to 1000 ft apart and were spotted to give maximum information. Wide hole spacing is believed to be justified because of tight surface control of geology. Core holes were either vertical or inclined, depending upon local structures. Where possible, cores were cut perpendicular to the bedding. After drilling, cores were split down the center, described in detail, and the geologic cross sections were redrawn using the new data. Plate II shows some typical cross-sections of the property. Except that the structural complexities are more severe than usual in the Hudson Valley, they are fairly typical of the area.

TESTING OF AGGREGATE MATERIALS

As can be seen from the cross sections, the New Scotland limestone lies between the upper and lower cement series. Development of large tonnages of rock suitable for manufacture of portland cement required that the New Scotland formation either be stripped at considerable cost or used in some manner. The author's experience in the Hudson Valley indicated that although the New Scotland limestone was generally believed to have no economic value, it was entirely possible that the stone might serve as a suitable coarse aggregate for concrete.

Systematic duplicate testing of cored material verified the hypothesis by demonstrating that the New Scotland limestone passed all of the stringent New York State specifications for coarse aggregate. On this basis it was recommended that Hudson Cement begin production of crushed stone. An economic sidelight on the changed status of the New Scotland limestone is that it has the effect of multiplying reserves of portland cement rock in New York State, possibly by a factor of five.

Table I. Reproducibility of MgO Content (%) at Laboratories X, Y and Z

Interval	Lab. X	Lab. Y	Lab. Z
a	0.94	3.20	0.16
b	1.21	1.0	0.14
c	2.95	3.62	0.98
d	7.77	5.74	7.01
e	1.31	3.12	0.47
f	3.43	2.90	2.80
g	4.12	4.22	4.66
h	2.47	3.62	2.19

CHEMICAL ANALYSIS OF CORES

Selection of core intervals to be sampled represents a special problem. Analyses taken of standard intervals of, perhaps, 10 ft would not give significant data because the attitudes of beds varied from horizontal to vertical and because faults containing secondary carbonate and jumbled limestone fragments were common. Therefore, selection of analytical intervals is stratigraphically controlled, i.e. the same interval of rocks should always be tested. (Complicated fault zones were not tested.) In order to do this in the Hudson Valley, cores must be described in detail by a geologist and the distinctive layers noted. Sample intervals are the intersected thicknesses of stratigraphic units to be tested and are of highly variable length for any given unit, i.e. a layer which is 8 ft thick in one core may be 50 ft thick in another depending upon the angle of intersection of the core with the layer. True thickness of layers tested varies from about 2 ft to 15 ft.

One advantage of such sampling is that many layers are extremely constant in composition, and

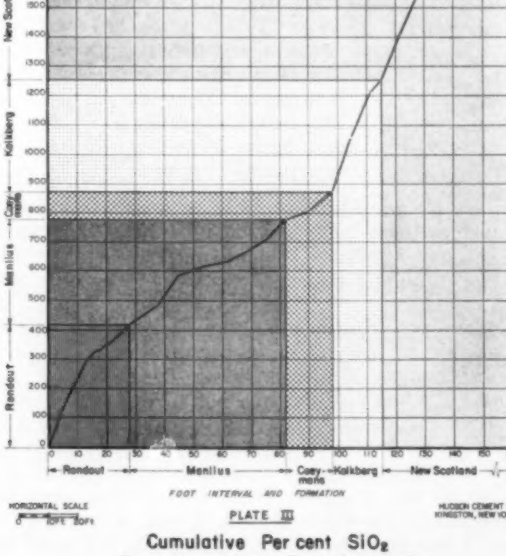
once a few analyses establish this compositional constancy, the layer need not be analyzed again. Conversely, the more normal procedure, which is used by many companies, of sampling at regular core intervals can not determine such constancy.

In a recent drilling campaign, many rock samples were crushed and split and sent to various laboratories. Table I shows the analyzed MgO contents of three series of samples which were crushed, thoroughly mixed and sent to three different laboratories. Of 24 analyses, nine (the italicized figures) were significantly in error. In addition, rechecks of the above layers in many areas indicate that several other figures on the table are also probably erroneous. Similar problems were encountered for all oxides.

On the basis of checks of the analyses against each other it could be shown that: 1) analytical variation between laboratories on identical samples is far greater than the variation within an individual rock layer; 2) the predictable analytical error within any one laboratory is probably far greater than the chemical variation within an individual rock layer; 3) a calculated, weighted average chemical composition of a stratigraphic unit is a more accurate determination of composition of that mass than any other reasonable method.

DETERMINATION OF COMPOSITION OF QUARRY FACES

Once the average compositions of the identified rock strata have been determined, working out the composition of a quarry face becomes a problem of geometry and chemistry. The method devised at Hudson Cement has been found to be simple and rapid. Personnel without geological training can use the method quite satisfactorily, and the average compositions of all faces in a complex quarry operation can be determined in a few hours. The method has proven accurate enough so that no other checks of composition of quarry faces are now used and no drilling is done ahead of faces.

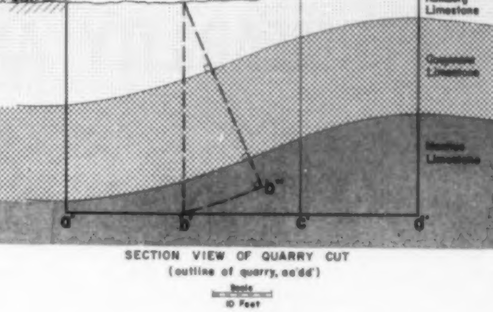


HORIZONTAL SCALE
0 10FT. 20FT.

PLATE III

HUDSON CEMENT CO.
KINGSTON, NEW YORK

Cumulative Per cent SiO_2
Plotted against Foot Intervals



SECTION VIEW OF QUARRY CUT
(outline of quarry, aa'dd')

Scale
10 Feet

PLATE IV

Typical Construction Lines for Graphic Method of Determining Composition of Quarry Face

The first step is to plot cumulative percent of various oxides against cumulative stratigraphic intervals. Plate III is an example of such a plot. Cumulative percent is determined by multiplying true thickness of each rock layer by the percentage of oxides in question and adding the figures so obtained on the ordinate. For instance, if an interval is 8 ft thick and the CaO content is 30%, the weighted percent is 240. This figure is added to similarly obtained figures for the stratigraphic units below. The technique is somewhat similar to the foot-percent or inch-pennyweight calculations of ore grade which are so common in mining practice. The formation name and foot intervals are plotted on the abcissa.

An example of use of the chart is as follows: the total percent SiO_2 in the interval 70 to 106 (from 12 ft below the Manlius-Coeymans formation contact to 24 ft above) is 1085-676 or 409%. The average SiO_2 content of this interval is $409/36 = 11.4\%$. We known from this that rock material of a somewhat higher SiO_2 content must be blended with this rock to come closer to a portland cement raw mix. It should be reemphasized here that such a procedure is justifiable only if rock layers have relatively constant compositions.

In practice, the problem of determining composition of quarry faces is more complex because of folding and faulting. Plate IV is a cross section of a typical quarry face showing folded strata. Average composition of the face is determined by calculating the composition of selected vertical lines on the face and averaging them. In this case, because the beds are tilted, it is necessary to construct auxiliary lines which are perpendicular to the beds to represent the stratigraphic interval from 12 ft above the Coeymans-Kalkberg formation contact to 21 ft below the Coeymans-Kalkberg contact. This interval of 33 ft on the chart of Plate III has a cumulative percent of 455 and therefore the average is 455/33 or 13.8% SiO_2. In a similar manner, composition of lines aa', cc' and dd' can be determined. The average weighted composition of the lines is the composition of the face.

An added advantage of the method is that composition of rock moved by a shovel from any particular part of a shot lying on the quarry floor can be approximated by using the information of the chart and the knowledge of the distribution of rock thrown by the shot.

PERMEABILITY AND COMPRESSIBILITY TESTS AID IN SELECTING SUITABLE HYDRAULIC FILL MATERIALS

by DAVID G. MICKLE and HOWARD L. HARTMAN

Hydraulic filling was probably first used as a means of ground support in 1864 in an anthracite mine at Shenandoah, Pa. In the nearly 100 years since that time it has gained widespread acceptance, but surprisingly little study has been made of the basic features of the process. The investigations that have been made primarily concern the design of preparation processes and transportation systems, while little attention has been paid to ensuring that the fill does its job adequately after placement.

Both permeability and compressibility of fills have been studied in the laboratories of the Department of Mining at The Pennsylvania State University under the sponsorship of the Mineral Conservation Section, formed to promote efficient utilization of the state's resources. Results of these studies form the basis of this article.

PERMEABILITY

Rapid drainage of water is recognized as an important requirement for hydraulic fills. If the fill exists in a semifluid condition, either through inadequate drainage initially or through subsequent infiltration and retention of water, rock pressures imposed on the fill will be transferred to bulkheads, and their rupture may occur. In addition, it is often desirable that the fill be solid enough to walk on within a few hours after placement. Permeability is therefore an important measure of suitability of a hydraulic fill material. The authors have studied flow of liquids, particularly water, through porous materials, especially those used as fill in anthracite mines, and have established their respective units of permeability.

Effect of particle size: It is known that fine materials, in general, have a lower permeability than coarse ones. Materials available for hydraulic filling at most mines are quite fine grained, and it is therefore necessary to remove the finest of this material (the slimes) to insure adequate drainage. But before the required preparation process can be designed, two questions must be answered: 1) what permeability is considered adequate, and 2) what particle-size distribution will have this permeability?

The first question was investigated at one mine by model studies and actual practice with the conclusion that a permeability of 4 in. per hr was the minimum acceptable. This figure has been adopted at other mines and has even come to be accepted generally as a "standard," although it is doubtful that the differences in filling conditions which exist between mines would justify use of the same index rate in all cases. This is a matter which is badly in need of study.

The second question has received many rule-of-thumb answers which usually give the maximum amount of material allowable below a stated size. Some of these "standards" which have been prescribed are:

15% below 200 mesh
50% below 200 mesh
10% below 325 mesh
13% below 325 mesh
3½% below 20 micron
0% below 10 micron

There is obviously contradiction which would indicate that these rules are not universally applicable. Each was developed for the material in use at a single mine and apparently does not apply to other materials.

Tests were run on a number of materials that are available for use as fill in the anthracite region of Pennsylvania. These included five sizes of coal washer refuse (3 in. 100 mesh, Nos. 4, 5 and 6 buckwheat, and minus 1 in.), boiler ashes and alluvial sand. All of these except the minus 1 in. refuse and sand were highly permeable, ranging from 11 to to 48 in. per hr. The minus 1 in. refuse (pea and smaller) had a permeability of only 0.8 in. per hr, but it has been successfully used for filling at one mine. Removal in the runoff of the 3.5% of this ma-

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terial which is below 30 micron probably brings the permeability of the remaining fill up to acceptable limits. The alluvial sand had a permeability of 0.5 in. per hr, but the removal of the 3.2% below 30 micron increased its permeability of 6.3 in. per hr.

Permeability of stratified fractions: Rather than to set a limiting value of the screen analysis of fill materials, a slightly different approach would be to predict the permeability of a material from its screen analysis and compare this with the previously determined "acceptable" value. There have been many attempts to make such predictions for soils and similar materials, but none has met with widespread success. The problem is really a formidable one because almost infinite variations are possible in particle-size distribution, particle shape, particle arrangement and porosity, all of which have an effect on permeability. To illustrate the wide disagreement among investigators, one derived a formula for predicting permeability as being proportional to the seventh power of porosity, while another found it independent of porosity (Dalla-Valle, 1948).

Hydraulic fills, however, have a distinctive feature which makes them a special and simplified case in the prediction of permeability. Because of their method of placement, hydraulic fills settle in water and become stratified by particle size as they do so.

If the particles in all layers have the same specific gravity, and if each layer has the same porosity, a formula derived from one developed by Terzaghi (1943) permits a prediction of permeability of stratified fractions.

If, in addition, it is assumed that the separate layers are composed of particles between successive screen sizes, a screen analysis may be used to obtain the weight of each layer. All that remains to be measured is the permeability of each size fraction, and once this is done, the permeability of any combination of these size fractions can be predicted.

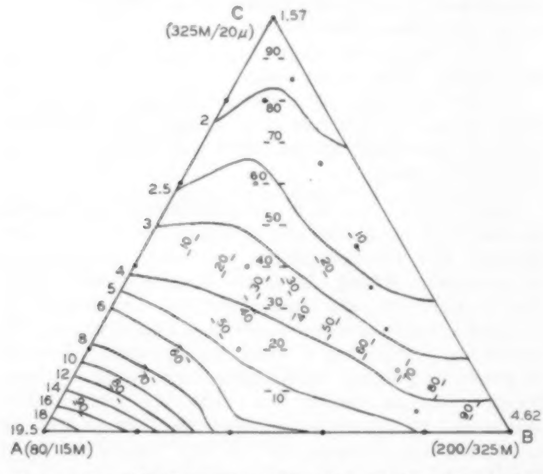

Fig. 1—Results of tests for the effect of size distribution on permeability made with three sizes of glass spheres are shown in diagram. Point A represents spheres of 80/115 mesh, point B 200/325 mesh and point C 325 mesh/20 micron. The fact that the lines of equal permeability (isoperms) are not parallel to the triangular coordinates indicates that the percentage of any one component cannot define the permeability of a mixture. Thus, samples which had permeability of 4 in. per hr could contain from 0 to 62% of component A, 0 to 92% of B and 8 to 38% of C. A permeability equation can be taken from any standard soil mechanics text. Tests were run in a falling head permeameter. The isoperms are plotted on chart with K values in "in. per hr."

A series of laboratory experiments was performed to test the validity of this method of predicting permeability. Samples tested included glass spheres, mill tailings, sand, ashes and coal washer refuse. The permeabilities of narrow size fractions were measured and then the permeabilities of various combinations of these sizes. Permeability was also predicted by formula, and the actual and predicted values were compared.

Agreement is fairly good up to a permeability of about 6 in. per hr, but above this, the points diverge widely from the line of perfect agreement (Fig. 2). It is believed that the fluid flow through the more highly permeable materials was not in the laminar range. Permeability is a constant for a given material only when flow is laminar.

Fortunately, insofar as conformance to formulas is concerned, it is materials of low permeability with which we are most concerned in hydraulic filling. A material which has a permeability of more than 6 in. per hr will probably cause no problems in filling, so an exact determination of its permeability is not necessary.

The largest error in predicting permeability below 6 in. per hr was 18%. This accuracy is sufficiently good for hydraulic filling purposes, considering the magnitude of permeability changes with which we are concerned. For example, removing the minus 325 mesh material from the mill tailings sample raised its permeability from 0.099 to 13.3 in. per hr.

This study has only scratched the surface of the permeability problem, but it has indicated that a quantitative approach to permeability predictions is possible. It is hoped that further research will expand the usefulness of the ideas developed here.

COMPRESSIBILITY

A second important characteristic of fills is compressibility. No fill material is incompressible, but it is obviously desirable that a fill material have as low a compressibility as possible if excessive rock movement is to be prevented. It is therefore important to know how a material of low compressibility may be recognized. In conjunction with the permeability tests, the compressibility of several of the samples was determined.

Fig. 3 shows the curves of sample height vs. applied pressure for ten materials tested. Several interesting features of the compression process are illustrated.

1) Loss of height is rapid at first, but the curve eventually levels off so that a limiting percentage of original height may be reached for each material below which it cannot be significantly compressed under normal rock loads. This point was probably reached with the mill tailings and perhaps the sand.

2) Both the percentage of original height and the pressure at which leveling-off occurs vary for different materials. The sand sample could probably never be compressed much below 90% of its original height, while Nos. 4 and 5 coal refuse samples were below 60% at 1400 psi.

3) All of the samples were tested in a "drained" condition; i.e., they were allowed to stand until water ceased to drip from the bottom of the sample before testing. However, the tailings were retested

after oven-drying first for five hours, and the result of this test is also shown. Compressibility is less for the dry sample, which probably results from increased friction between particles. Normally, fills retain 10 to 15% moisture and would have characteristics intermediate between the drained and oven-dried conditions.

4) No simple relationship was evident between compressibility and average particle size, uniformity of particle size, permeability or porosity. The most that can be said is that similar materials had similar curves. Thus Nos. 4, 5 and 6 coal refuse had closely similar screen analyses, as did the sand and "sand, plus 325 mesh" samples.

In conclusion, it may be said that it is of obvious interest to know whether a material intended for use as hydraulic fill will compress 10% or 40% under the anticipated rock load. However, no method of predicting the compressibility of a material from its composition or particle-size distribution was apparent from the few tests reported here. Further studies which disclose such a method of prediction would be a valuable contribution to our understanding of hydraulic filling.

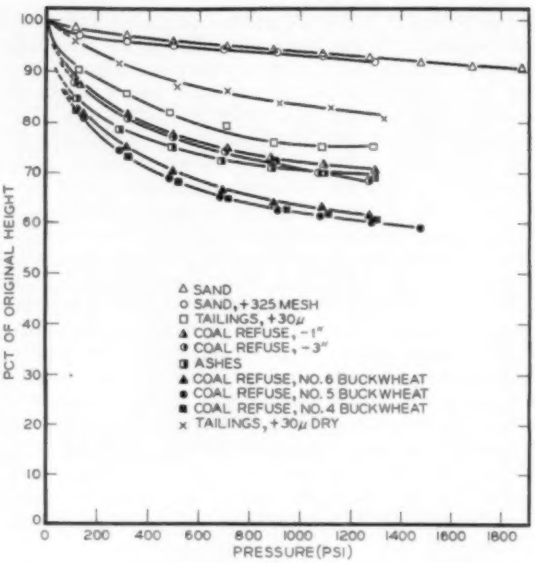

Fig. 3—Compressibility tests show leveling off so that a limiting percentage of original height may be reached for each material below which it cannot be significantly compressed under normal rock loads.

CONCLUSIONS

1) All of the materials obtained in the anthracite region of Pennsylvania were suitable, from the permeability standpoint, for use as hydraulic fill. Two materials (alluvial sand and minus 1 in. washer refuse) would require removal of the small amount which is below 30 microns. This removal would probably occur in the runoff during filling, without special treatment.

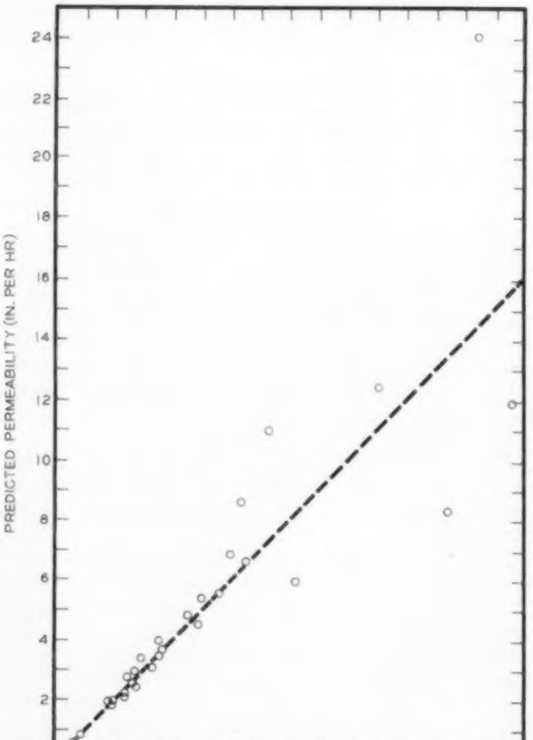

Fig. 2—Comparison of measured and predicted permeabilities shows fairly good agreement up to permeability of about 6 in. per hr. In the more permeable material, liquid flow was not laminar, so causing divergence from the prediction.

2) The size-stratification theory affords a means of predicting fill permeabilities below 6 in. per hr, the range of main concern in hydraulic filling.

3) The degree of compression (decrease in height) at 1200 psi varied from 7% for sand to 38% for Nos. 4 and 5 buckwheat coal washer refuse. The compression curves for all materials tended to level off at high pressures.

4) Fill material when dry had a lower compressibility than when wet.

5) On the basis of permeability and compressibility tests, the alluvial sand sample was the most suitable for filling of the materials obtained in the anthracite region.

The permeability and compressibility studies reported here have laid the groundwork for a quantitative and comprehensive approach to problems of hydraulic filling. Perhaps their greatest value lies in disclosing the wide variations in permeability and compressibility which are found among fill materials, indicating a need for accurate methods of predicting these variables before putting a material to use. A method for predicting permeability was tested and found to have promise, but no method of predicting compressibility was apparent from the limited number of tests performed.

The authors wish to express their appreciation to the Mineral Conservation Section of the College of Mineral Industries for supporting this research. Cooperation of many mining companies in Pennsylvania who contributed information and samples is gratefully acknowledged. This article was based on a thesis submitted by David G. Mickle in partial fulfillment of requirements for master of science degree in mining engineering at the Pennsylvania State University. Contribution No. 60-108 from the College of Mineral Industries.

Annual Meeting Program and Abstract Section

Calendar of Events

SME sessions, AIME sessions of interest to Society Members, and social events at the AIME Annual Meeting in New York, February 18-22, 1962.

All events listed below are at the Statler-Hilton unless otherwise indicated.

Sunday

SME Program Committee
9:00 am - 5:00 pm, Hartford Room

AIME Board of Directors
2:00 - 5:00 pm, Penn Top North

SME Education Committee
2:00 - 5:00 pm, Penn Top South

Monday

SME Authors' Coffee Hour
8:45 - 9:15 am, Georgian Foyer

SME Board of Directors
9:30 am - 12 m, 2:30 - 5:00 pm. Hartford Room

Coal Symposium on Dust Collection
9:30 am - 12 m, Ivy Suite

MBD-EMD Chemical Process
9:30 am - 12 m, Sky Top

M & E Open Pit Mining
9:30 am - 12 m, Georgian Room

SEG General Geology
9:30 am - 12 m, Penn Top North

AIME Welcoming Luncheon
12:15 - 2:15 pm, Grand Ballroom

Coal Symposium on Research in Coal Mining
2:30 - 5:00 pm. Ivy Suite

IndMD Minerals for Special Uses
2:30 - 5:00 pm, Penn Top North

MBD Operating Controls
2:30 - 5:00 pm, Sky Top

MBD Crushing and Grinding
2:30 - 5:00 pm, Terrace Ballroom

M & E Underground Mining
2:30 - 5:00 pm, Georgian Room

Council of Economics Mineral Imports and Stabilization Policy
2:30 - 5:00 pm, West Room

SEG General Geology
2:30 - 5:00 pm, Penn Top South

AIME Cocktail, 6:00 pm, Party Penn Top

Dinner Smoker, 7:00 pm, Grand Ballroom, Sheraton-Astor Hotel

Tuesday

MBD Scotch Breakfast, Business Meeting
7:30 - 10:00 am, Terrace Ballroom

SME Authors' Coffee Hour
8:15 - 8:45 am, Georgian Foyer

Coal Materials Handling
9:00 am - 12 m, Ivy Suite

IndMD Industrial Waters
9:00 am - 12 m, Penn Top North

MBD Mill Design
9:00 am - 12 m, Sky Top

M & E Geological Engineering
9:00 am - 12 m, Georgian Room

Council of Economics Impact of 1960-61 Developments in Foreign Investments
9:00 am - 12 m, West Room

Council of Economics Luncheon
12:15 - 2:00 pm, East Room

IndMD Luncheon
12:15 - 2:00 pm, Terrace Ballroom

Coal Division Luncheon
12:15 - 2:00 pm, Penn Top Center

SEG Luncheon
12:15 - 2:00 pm, To be announced

AIME All-Institute Session
2:30 pm, Grand Ballroom

AIME All-Institute Business Meeting
4:30 - 5:00 pm, Grand Ballroom

Coal Division Open Business Meeting
4:30 - 6:00 pm, Ivy Suite

IndMD Business Meeting
4:30 - 6:00 pm, Hartford Room

SME Cocktail Party, 6:00 pm, Georgian Foyer

SME Dinner
7:00 - 10:00 pm, Georgian Room

AIME All-Institute Informal Dance
9:00 pm - 1:00 am, Terrace Ballroom

Wednesday

SME Authors' Coffee Hour
8:15 - 8:45 am, Georgian Foyer

Coal Preparation Plant Design and Automation
9:00 am - 12 m, Ivy Suite

IndMD-MBD Concentration
9:00 am - 12 m, Penn Top North

MBD Materials Handling and Storage
9:00 am - 12 m, Sky Top

MBD-EMD-ISD Basic Science
9:00 am - 12 m, Gold Ballroom

M & E and SEG Epigenesis vs. Synigenesis
9:00 am - 12 m, Georgian Room

Council of Economics Forecast of U.S. Fuel Requirements
9:00 am - 12 m, West Room

M & E Luncheon
12:15 - 2:00 pm, Gold Ballroom

M & E Jackling Lecture
2:00 pm, Georgian Room

Coal Symposium on Safety and Ventilation
2:00 - 5:00 pm, Gold Ballroom

Coal Symposium on Maintenance and Automation
2:00 - 5:00 pm, Ivy Suite

IndMD Exploration for Industrial Minerals
2:00 - 5:00 pm, Penn Top North

MBD Concentration
2:00 - 5:00 pm, Sky Top

Council of Economics Operations Research in Mining Industry
2:00 - 5:00 pm, West Room

M & E Business Meeting
4:00 pm, Georgian Room

AIME Annual Banquet and President's Reception
7:00 pm - 1:00 am, Grand Ballroom

Thursday

SME Authors' Coffee Hour
8:15 - 8:45 am, Georgian Foyer

Coal Utilization
9:00 am - 12 m, Ivy Suite

MBD Pyrolysis and Agglomeration
9:00 am - 12 m, Sky Top

M & E - SEG Major and Minor Elements in Host Rocks
9:00 am - 12 m, Georgian Room

MBD Luncheon
12:15 - 2:00 pm, Grand Ballroom

Coal Symposium on Bituminous Mining Systems
2:00 - 5:00 pm, Ivy Suite

MBD Solid-Fluid Separation
2:00 - 5:00 pm, Sky Top

M & E Geophysics
2:00 - 5:00 pm, Georgian Room

SOCIETY OF MINING ENGINEERS

1962 ANNUAL MEETING PROGRAM

This Section outlines the Technical Program for sessions sponsored by the Society of Mining Engineers and its Divisions. Titles of all papers are listed under Division headings alphabetically according to author. All abstracts received by September 25 are included in the following pages. Those received after that date will appear in the January issue of MINING ENGINEERING. An Available Preprint List, by number, will be published in a subsequent issue. **Do not order until this list appears.**

EDUCATION COMMITTEE

Sunday, February 18

2:00 pm, Penn-Top South

Co-Chairmen: William C. Lacey, William C. Kelly

Changing Government Policies and Laws and Their Effect Upon the Mineral Industry by *Charles H. Behre, Jr.*

Developments in the Field of Rock Mechanics by *J. J. Reed.*

The Place of New Analytical Methods in the Mineral Industries by *W. M. Tuddenham* and *A. C. Francis*—A research, control or cost accounting program is no better than the analyses upon which it depends. In order to remain competitive, either in the mineral industries or in other areas of production, a continuing program of development and evaluation of analytical methods, both classical and instrumental, must be maintained. In recent years there has been a continually increasing use of instrumentation in lieu of classical chemical methods. For the most part, the newer techniques are utilized for plant control work or for analyses which could not be performed by any other means rather than for metallurgical accounting purposes. Lack of understanding of the true place of many of the newer techniques in the overall production program has led to considerable confusion. As a result, attempts are often made to apply instrumental techniques in areas for which they are ill suited, or at the other extreme, obsolete methods are utilized unnecessarily. The mineral industries will benefit greatly if new graduates can be given a clearer picture of the vital importance to the industry of the proper choice of analytical methods, along with a clearer understanding of the strong and weak points of both classical chemical methods and the newer instrumental methods.

Utilization of Operations Research Techniques in the Mining Industry by *E. L. Vickers.*

COAL DIVISION

Symposium on Dust Collection

Monday, February 19

9:30 am, Ivy Suite

No information available at this time—see January issue.

Symposium on Research in Coal Mining

Monday, February 19

2:30 pm, Ivy Suite

Co-Chairmen: J. Richard Lucas, James E. Brown

Permeability of Coal to Flow of Gas, by *William H. Huang* and *T. Carl Shelton, Jr.*—One of the problems of the use of modern machines and systems in coal mining is increased emission of explosive gases into the mine passageways. Many mines have their rates of extraction and advancement more limited by the capacity of their ventilation systems than by the capabilities of their equipment. As a result, interest in degasification of coal seams has grown and several investigations of gas flow in coal beds have been made in recent years. This paper summarizes some of the research that has been done at Virginia Polytechnic Institute.

The Role of the Office of Coal Research, by *Wayne A. McCurdy*—The work of the Office of Coal Research will complement the work done by the U.S. Bureau of Mines. Its work is concentrated primarily on short-range projects aimed at providing the most immediate value to the coal industry, as compared to the longer-range basic research programs of the Bureau. Many of these programs are now underway and numerous others are being evaluated. The major objective of the Office of Coal Research is to expand coal markets through new and efficient mining, preparation and utilization. Success will be measured by the volume of tonnage expansion.

Evaluation of Specific Rock Properties by Ultrasonic Principles by *Howard E. Rutherford* and *J. Richard Lucas*—The primary objective of this research was to evaluate the feasibility of ultrasonic testing for the purpose of analyzing the structure and properties of rock material. A secondary objective of this research was to determine experimentally the elastic constants of various rock specimens with the use of ultrasonic equipment. Elastic constants can definitely be determined quickly and accurately by ultrasonic investigation. With proper equipment there are indications that ultrasonic waves could be utilized in the detection of flaws, such as fractures and planes of weakness, measurement of thickness and the study of structure, of rock material.

Materials Handling

Tuesday, February 20

9:00 am, Ivy Suite

No information available at this time—see January issue.

Preparation Plant Design and Automation

Wednesday, February 21

9:00 am, Ivy Suite

Design of a Preparation Plant for Minimum Maintenance and Clean Up by *Donald H. Dowlin*—The design of a preparation plant for minimum maintenance and clean up requires both the skills of the engineer and the practical experience of the operator. From the initial flowsheet and preliminary design until the plant is completed and operating, each phase of the work must be thoroughly explored for simplicity, workability and high efficiency. It is the responsibility of the designing engineer to develop the plant around the basic flowsheet, selecting equipment and materials not only with regard to initial cost but also required upkeep and repair.

Symposium on Maintenance and Automation

Wednesday, February 21

2:00 pm, Ivy Suite

Co-Chairmen: D. C. Ridenour, R. W. Storey

Automation—Designed for Maintenance by *Robert R. Godard*—A discussion of the engineering and design criteria for construction of automated systems to yield maximum operational reliability and minimum downtime for either emergency or preventive maintenance. Engineering factors recognized include component rating and selection, environmental influences, wiring methods, fault indicating devices and others. Development of routine and emergency maintenance test procedures, establishment of minimum training standards and specification of suitable test equipment are included as joint responsibilities of engineering, maintenance and training functions.

Maintenance and Operation of High Capacity Underground Mining Machinery by *John S. Newton*—Much progress has been made by mine operating personnel in the maintenance and utilization of new high-capacity machinery developed in recent years. The actual capacity of a mining machine is determined by its capability and the continuity of operation possible. The capability of these machines is appreciably less than the maximum capacity because it is necessary to provide excess capacity to compensate for operating conditions. As the ability of the machines to do more work is increased, it is necessary to increase the driving power. These larger power machines are expensive, heavy and time consuming to replace. The general trend in making the machinery suitable for increased work is to provide protection devices and controls that will assist the operating personnel to maintain maximum capacity with a minimum of downtime due to failure of components.

Trained Manpower and Progress in the Mining Industry by *James L. Patton*—Automation of mining increases productivity of labor, thereby reducing the unit labor cost. Labor cost constitutes the largest portion of the direct or variable cost of producing coal. Therefore, any increase in productivity reduces the variable cost. The large investment in mechanical equipment carries with it the burden of increased fixed charges. As the proportion of the fixed to the total cost increases, the effects on the cost of production changes are amplified. Therefore, equipment must be fully utilized at all times. This takes trained manpower, and in order to have such manpower, there must be a recruitment and selection program together with a systematic plan of training people for specific responsibilities in the mining and processing of coal.

Automation and Maintenance by *C. L. Sarff*—This paper emphasizes the necessity for scheduled testing and maintenance to successfully operate automated and semi-automated equipment.

Symposium on Safety and Ventilation

Wednesday, February 21

2:00 pm, Gold Ballroom

Co-Chairmen: R. Ward Stahl, J. D. Kalasky

Determining Ventilation Requirements with Continuous Miners by *Howard L. Hartman*—Auxiliary or face ventilation in any production section is usually carried out for one reason: control of methane gas by dilution. Unfortunately, the need for dust, heat and/or humidity control is overlooked or ignored. The determination of face ventilation requirements in a continuous miner section must be based on a consideration of the total ventilation-air conditioning needs in the working section, if human safety and comfort is to be adequately protected. Since the governing factor in determining the quantity (cfm) of air required is usually con-

taminant dilution, two criteria need to be considered: 1) dilution of all contaminants, gas and dust, to the threshold limits and 2) maintaining the velocity of the airstream above the critical level to insure turbulent flow. The latter is often neglected, except in large places or in pillar recovery where it may govern. In determining cfm, a distinction must be made between the instantaneous and sustained rate of methane emission. A hazard may exist even if sufficient air is provided to dilute the "average" inflow of methane to the legal limit. The time it takes to achieve dilution must also be considered and may be important when encountering "blowers" or pockets of gas.

Ventilation of Gob Areas and Use of Bleeder Systems by *Stephen Krickovic*—"Bleeding" means controlled movement of air across and away from active pillar lines and into headings (bleeders) provided for the purpose. The objective is to maintain a reasonably methane-free belt adjacent to the working places so that, with a possible temporary interruption in face ventilation, methane will not create an explosive hazard.

For proper control, there must be available adequate air pressure differential between the front and back ends of a pillar line. If air is allowed to seek its own course across a gob, it will take the shortest and least obstructed one and very probably will not clear out the gas satisfactorily.

With improper bleeder setup and control, regulation of an active air split is introduced, at times, on the intake end. This will reduce the desirable pressure differential already mentioned and could create a hazard.

Actually, it is just as important in gaseous mines to design a ventilation system that will satisfy effective bleeding requirements as it is to satisfy the air volume requirements in operating splits. This will involve an extra 0.50 in. to 1.00 in. of watergauge and 50 to 100 hp in a mine ventilated with 400,000 cfm of air and 5.0 in. of watergauge—a reasonable price for protection against methane accumulation.

Fighting Mine Fires, by *Donald M. Mitchell* and *John Nagy*—An underground fire, if not extinguished quickly, can develop rapidly, create a serious hazard and cause loss of life and property. Fires in mines present a far greater hazard than fires in other industrial plants; however, a survey conducted by the U.S. Bureau of Mines indicates that fire protection in the least equipped plant studied was equal to or better than the protection in the best equipped mine. Some of the time-tested safeguards used in the mining industry have been shown by experiments and experience to be inadequate to meet the intensified fire hazard resulting from rapid improvements in mechanized mining and marked increases in productivity. Extinguishing agents and methods of controlling underground mine fires were investigated at the Bureau's experimental coal mine. The results of these investigations and suggestions for reducing the fire hazards are discussed.

Roofbolting Experiments by *Robert Stefanko.*

Coal Utilization

Thursday, February 22

9:00 am, Ivy Suite

Co-Chairmen:

Automatic Sampling of Railroad Cars at Dockside Dumping Points by *Melvin W. Dadd* and *Loy A. Updegraff*—Because one of the major problems in the purchase and sale of lake coal has been the difficulty in obtaining a true analysis of the shipped coal's quality, The National Coal Assn., with the assistance of Bituminous Coal Research, initiated a program for the development of an automatic coal sampling system on the high lift coal dumpers at lake ports.

This paper outlines the results obtained from the design and testing of a sampling device that is attached to the cradle of the high lift dumper. The tests show that the car dumper sampling device will, within very close tolerances, reproduce the results obtained from mine samples.

Direct Operating Efficiencies for Modern Coal Heating Equipment by *R. J. Grace*—Direct efficiencies of 76.8% and 77.3%, respectively, for over-all operation (run and bank) and run operation only, were obtained from tests on large tonnage shipments of ten different coals from several different seams and ten different sources. The tests were conducted by normal plant personnel without outside supervision over a period of several months during the 1960-61 heating season. The total coal (300 tons) used represented about 26% of the yearly plant requirements. The tests were conducted on a 200-hp Coal-Pak hot water generator equipped with an electronic type Btu meter which continuously indicated and recorded the total heat output of the boiler.

The direct daily efficiencies which ranged from a low of 70.2% to a high of 83.3% compared favorably with those obtained from four-hour tests on a 300-hp Coal-Pak steam generator, which averaged 81.9%. The latter efficiencies were obtained by the indirect method.

A Review of Coal Processing Methods by *Harry Perry*—In the U.S., coal processing consists essentially of coal carbonization, although great interest has developed in a number of other coal processing methods which may develop in the future. Gasification, which was once an important coal processing method in the U.S., is once again becoming of interest since it may be attractive to compete with natural gas in the form of producer gas for glass manufacture, lime burning, etc. Complete gasification of coal using steam and oxygen to produce synthesis gas with its further conversion to high-Btu gas, although only in the experimental stage, also appears to offer long-term possibilities for coal markets. Conversion processes for coal leading to liquid fuels and chemicals, however, do not appear to be as economically favorable at this time. Low-temperature carbonization still has proponents for use in producing either chemicals or liquid fuels, although no new commercial developments are presently underway.

Numerous other coal processing methods, such as oxidation of lignite to leonardiee for use as a drilling stabilizer, treatment of coal to make an ion exchange material, and other processing methods are still being investigated, although only small-scale outlets for materials produced by any of these methods exist at present.

Continuous Manufacture of Coke in a Rotary Hearth Furnace by *J. B. Taggart* and *Thomas Lloyd*—This paper deals with the original conception of the process with anticipation of 1) low labor, supply and maintenance costs; 2) low capital costs; 3) ability to convert low cost coals; 4) ease of crushing problems; 5) moisture reduction; 6) possible gas recovery; 7) atmospheric pollution control. The pilot furnace which was built is described. Complete history of preliminary operation is discussed with data on production and quality of product for various coals and various end products, i.e. sinter fuel, electric furnace coke, char, etc. Reference is made to calcining petroleum coke and anthracite coal. A discussion of operating problems encountered and methods of solution are included. The furnace has been shut down for modification and study of wear, erosion, etc. This is covered in the report. Plans for future commercial production are discussed with data relative to feed material and manufactured product. Capital costs and operating costs are covered and a final up-to-date evaluation of the process is included.

Symposium on Bituminous Coal Mining Systems

Thursday, February 22

2:00 pm, Ivy Suite

Co-Chairmen: G. W. McCaa, D. A. Zegeer

High Capacity Rail Car Loading and Hauling System by *Mack H. Shumate*—This paper describes a railroad car loading and haulage system capable of handling 1800 tpd. It is composed of two tracks equipped with separate hoisting systems employing the use of a dolly car coupled to the empties or loads, whichever the case may be. The two-track system is equipped with two hoists for each track which offers flexibility in loading and handling of the railroad cars for storage to be picked up by locomotive. Railroad car loading systems of this nature offer savings and capital investment and reduce operating costs to a minimum.

INDUSTRIAL MINERALS DIVISION

Industrial Minerals for Special Uses

Monday, February 19

2:30 pm, Penn Top North

Co-Chairmen: R. J. Lund,

Industrial Rare Earths—A Progress Report by *Howard E. Kremers*—The status of the American rare earth industry is reviewed from the standpoints of new technology, new developments and general trends. Thorium and yttrium materials are also included since they are directly related to rare earth production.

The Outlook for Mica by *S. A. Montague*—The postwar trend of reduction in demand for low qualities of block mica continues, while demand for the very top quality continues to expand. India production remains at a high level, bolstered by Soviet buying. Brazilian production is suffering from recent minimum wage increase and reduced demand for electrical qualities of mica. The rebellion in Angola has practically cut off supplies of mica from that country. Angola mica is generally of very high quality and difficult to replace from other sources. Domestic production will drop to an extremely low level if present subsidy program ends as scheduled June 30, 1962. Research continues on synthetic mica in two principal directions—attempts to "grow" larger synthetic crystals, and to perfect a process to reconstitute the powder ground from synthetic scraps into sheets. Pilot plant production of a synthetic sheet with a small binder content is reported successful, with the resulting product considered suitable for radio tube spacers or bridges. Replacement of natural mica in this application would mean reduction of more than 50% by weight of U.S. block mica consumption and intensify the problem of supply of very high quality mica for which there is no substitute in various electronic components.

No important new uses or applications for mica have appeared recently. The Mica Industry Assn. is sponsoring a very extensive research program to promote the mica industry to be financed by blocked U.S. funds in India.

Trends in Graphite Use and Supply by *John J. Schanz, Jr.* and *A. B. T. Werner*—The consumption of natural graphite in the U.S. reached a peak in 1955 and now appears to be entering a period of stagnation or possible decline. The total consumption of natural graphite reflects the growth, stagnation or decline of the various individual markets for graphite. In analyzing this current situation, the sources of supply of natural graphite are reviewed. Each of the major U.S. markets for natural graphite is discussed in terms of current behavior, competitive materials and future prospects.

New Beryllium Developments by *C. H. Smith, C. C. Woo* and *B. F. Dickerson III*—The purpose of this paper is to review the recent activities in beryllium exploration and processing and to present a hypothesis of the genesis of the beryllium deposits in the Spor-Topaz Mountain District, Juab County, Utah. New developments in both the pegmatitic and non-pegmatitic fields are reviewed. This discussion will include both exploratory and processing advances in North Carolina, Colorado, Utah and Nevada. New foreign developments in Mexico, Canada, South America and Africa are briefly discussed.

Industrial Waters

Tuesday, February 20

9:00 am, Penn Top North

Co-Chairmen: R. G. Kazmann, J. B. Graham

Water—Vital Raw Material in Mining and Processing Phosphate Ore by *L. A. Roe*—Water is used in enormous quantities by various types of mineral processing plants that produce materials having a wide range of value to mankind. None of these are more vital to

(Session continued on page 1252)

life than low-cost phosphate concentrates, without which food production would suffer a disastrous decline. Water demands for phosphate ore mining and processing are high, and as phosphate production from Western sources increases, adequate water supplies may be one of the factors limiting growth of the industry.

The fortuitous location of the major domestic production of phosphate ore in Florida, a state with plentiful supplies of water, has enabled the industry to more than meet the rising cost trend evident in almost all mineral products. The phosphate industry is aware of the value of its water resources and has long practiced conservation of this vital raw material.

Concentration

(Joint with MBD)

Wednesday, February 21

9:00 am, Penn Top North

Co-Chairmen: G. Komadina, O. M. Wicken

Marketing Problems in Industrial Minerals by *James E. Castle*—Fundamental considerations in the design of a marketing program for industrial minerals are that the number of potential customers for the typical industrial mineral is relatively small and that the small numbers are producers as opposed to consumers. The marketing program must therefore be tailored to fit the given mineral to be sold.

The essential foundation upon which to build an effective marketing program in industrial minerals is the ability to punctually produce and ship products meeting precise customer specifications. Without this prerequisite, all the other factors in a sound marketing plan—creative and energetic sales management, effective solicitation, advertising, new products, technical service—are without meaning. Product specifications can present very severe problems, and it is not unusual to discover that the technology to achieve quality control is uneconomic.

The image of the industrial mineral producer that must be created in the mind of the customer is that of the dependable, low-cost, fair-pricing, prompt shipper of quality-controlled mineral products. With this favorable image implanted it becomes possible to integrate into the marketing plan all the other factors to maintain and to increase sales.

The Mechanism of Flotation with Mercaptans by *P. L. deBruyn* and *F. F. Aplan*—A study has been made of the surface chemistry of a flotation system using a relatively volatile collector, hexyl mercaptan, and a gold surface. The adsorption was measured at both the solution-gas interface and at the gas-solid interface. Studies of vapor phase adsorption isotherms, the change in surface free energy at these interfaces was calculated by the use of the Gibbs adsorption equation. The surface free energy change, or surface tension, at the gas-solution interface, was measured directly. These data were then correlated by use of the Young equation: $\delta SG - \delta SL = \delta LG \cos\theta$ and the measured value of the contact angle. The data tend to support the contention that the greatest free energy changes occur at the gas-solid interface.

Flotation of gold with mercaptan occurs at low equilibrium concentrations, since at low concentrations most of the mercaptan added goes to the surface. Good flotation recoveries are obtained for 1) small surface coverages, 2) small changes in surface free energy and 3) small values of the contact angle.

Selective Froth Flotation of Ultra Fine Minerals or Slimes by *Ernest W. Greene* and *James B. Duke*—The application of a simple concept of an oiled carrier mineral to the flotation separation of micron and sub-micron sized minerals is described. Most of the paper is about the separation of the TiO_2 mineral anatase from kaolin clay fractions which are predominantly −10 microns and −3 microns in particle size. This separation is described in some detail as regards both laboratory results are presented on the recovery of apatite from phosphatic slimes which are about 50% finer than 0.3 microns.

Barite Production from Typical U.S. Deposits by *Earl Sackett*—This paper presents a review of some typical barite deposits in the U.S. with particular reference to their type and probable origin, and the mining and beneficiation methods utilized for production of them. Emphasis is placed on the residual deposits of Washington County, Mo. and the bedded deposits of the Magnet Cove area in Arkansas as major producers. Vein type deposits also are discussed and reference is made to other types in the residual and bedded classifications.

Exploration for Industrial Minerals

Wednesday, February 21

2:00 pm, Penn Top North

Co-Chairmen: P. M. Healey, J. C. Bradbury

Sources of Mineralizing Solutions in the Cave-In-Rock Fluorspar District by *E. A. Brecke*—Several features are described which can be logically interpreted as channels of ascent of mineralizing solutions from a deep source. The features are delineated on the basis of extreme volume loss by solution and deep stratigraphic occurrence of ore minerals.

The distribution of ore volumes from these points of ascent tend to confirm their nature as the ore occurrence or the greater portion of the occurrence is up-dip. This distribution provides a concept of lateral migration of solution under impervious beds. The mineral content of two of the orebodies also tends to confirm the direction of solution movement.

An Investigation of Hard-Metal Inserts for the Cutting of Slate by *Ivan F. Jackson* and *Howard L. Hartman*—Hard-metal inserts have received considerable attention in the mining industry recently for a variety of excavating and penetrating purposes. Their use in percussive drilling and in coal cutting machines is well known, but attempts to utilize them in cutting materials such as dimension stone have been discouraging because of excessive tool wear and failure. As a result, their use has not been widely accepted by the stone industry. It is considered that this is due to an incomplete understanding of the properties of hard-metal inserts as applied to fields other than percussive drilling and coal cutting.

In this paper, particular attention is given to those properties of hard-metal inserts that affect their resistance to wear. A consideration of the actual wear mechanism shows the importance of correct mounting of the inserts and of the selection of suitably powered driving motor so as to achieve minimum tool wear and maximum tool life. Comparisons are made between the performances of types of hard-metal inserts, relating their inherent properties with results obtained in laboratory tests.

Salt Deposits and Possible Future Discoveries in the Southeastern States by *William A. Riggs*—Recently, chemical manufacturers and salt producers have shown interest in salt resources located so as to economically supply growing demands for sodium chemicals and salt in the southeastern states. Concurrently, petroleum exploration has developed subsurface geological data affording valuable information on known salt deposits as well as defining areas geologically favorable or unfavorable for future possible discovery of salt deposits.

Maps and tabular data are presented which summarize the geological information, and analysis is offered in terms of possibility for future salt discoveries. Somewhat more detailed data are presented for a typical undeveloped shallow salt dome in southeastern Mississippi which is well located with regard to railroad and highway transportation, and also has possibilities for a brine pipeline to tidewater.

An attempt is made to analyze the consumption, origin and interstate transportation of salt in the southeastern states, and a brief summary is provided of the economics of the various forms of transportation of salt.

Evaluation of Bentonite Deposits by *Thomas W. Smoot*—Bentonites are composed chiefly of montmorillonite which is a clay mineral with very fine particle size and has large surface activity. Its uses are varied, and generally the best type of bentonite for one use is not necessarily the best for another use. For this reason, bentonites should not be evaluated on the basis of only one use.

The major uses of bentonites are briefly reviewed as are the mineralogical and chemical properties of montmorillonite. X-ray diffraction analyses, cation exchange capacity, differential thermal analyses and particle size analyses are important tools in the evaluation of bentonites. Field tests are generally unsatisfactory and should not be relied upon except for tentative identification.

The Use of Well Logs in Evaporite Exploration by *Robert N. M. Urash* and *Donald R. Richner*—Well logging is a rapid, relatively inexpensive technique. Properly used, it is one of the most versatile sources of subsurface information.

Many types of well logs are in current use. The more common measure such parameters as formation potential, electrical resistivity, natural or induced radioactivity, formation velocity, hole diameter and temperature.

Well log data can be used in the recognition of lithologic or time units; for correlation, preparation of cross sections, structure, isopach, facies and other types of subsurface maps; for the identification of or differentiation between various evaporite beds; or merely to provide desirable information on some specific physical rock property.

Successful well logging programs can be divided into four phases: 1) define the objective clearly, 2) review the limitations of the available well log types, 3) select and run the appropriate well logs, 4) interpret the well log data. Severe weakness in any one of these four phases may reduce the value of the well logging program or even lead to its complete failure.

MINERALS BENEFICIATION DIVISION

Chemical Processing (Joint with EMD)

Monday, February 19

9:30 am, Sky Top

Co-Chairmen: F. M. Stephens, Jr., R. W. Hernlund

Removal of Vanadium from Impure U_3O_8 Concentrate by *Clyde N. Garman*—Caustic precipitation of uranium concentrates from carbon leach circuits precipitates most of the vanadium that has been dissolved from the ore with the uranium. In order to meet specifications, excess vanadium must be removed. Discussion of various means considered and tried to make cleaner concentrates and the operation of the plants as finally installed.

The Physical Factors Governing the Leaching of Ores by *Nathan M. Levin*—A set of factors which govern the leaching of ores has been defined and organized into a logical system based on the elements of leaching, accessibility, physico-chemical interaction and transport. From this array a set of categories was chosen which permitted a regrouping of factors such as structural, fluid, common to structure and fluid, operational and chemical. A set of structural parameters was chosen and demonstrated to be useful leaching parameters. These include macropore volume, micropore volume, specific surface, pore size distribution and permeability.

Pilot-Plant Development of a Sulfation Process for Complex Sulfide Ores by *Robert E. Lund*—A complex sulfide ore containing lead, zinc and copper values has been treated on a pilot-plant scale in a process involving sulfate roasting, weak acid leaching, solution purification and electrolytic zinc deposition. The paper describes the pilot plant, discusses its operation, outlines the variables found to be of importance in the circuit and gives the results obtained from the pilot plant. In addition, the paper projects the pilot-plant results to predict commercial plant efficiencies.

Metallic Ion Adsorption by *E. A. Sigworth*—The use of activated carbon as an adsorbent for metallic ions is discussed in this paper. The past history is reviewed, specific examples of present uses are given and possible future applications are explored. Specific metal ions discussed include iron, copper, arsenic, tin, antimony, thallium, bismuth and molybdenum.

The Leaching Characteristics of Uranium from South Dakota Lignites by *Shiou-Chuan Sun* and *James W. Fetterman*—The lignites of South Dakota are a potential source for the production of uranium oxide. However, a number of problems exist which makes the

processing of these lignites difficult. Two of the major problems are the extremely variable uranium content of the lignite and the highly variable and different mineral content associated with the uranium. This paper deals with the effect these two problems have on the leaching of uranium in both acid and alkaline solutions. The results indicate that an acid leach will give the best results and that proper blending of the raw materials to give a feed with a relatively constant uranium content is desirable. Oxidizing is necessary for acceptable recovery. The contaminants which give the most difficulty are arsenic and molybdenum.

Oxidation of Galena in Acid Aqueous Media Under Pressure by *A. Vizzolyi* and *F. A. Forward*—The galena in lead concentrate, if it is to be extracted by amine leach solutions, must first be converted to $PbSO_4$ or basic $PbSO_4$. The experiments described show that PbS can be oxidized in an aqueous solution containing 1.05 mols H_2SO_4 per mol PbS at 90°C with a partial pressure of O_2 = 20 psi to convert 99% of the PbS to $PbSO_4$ in approximately 2 hours, the final pH being about 2.5 and elemental sulfur being produced. It is shown that Fe-ions must be present in the leach solution and that the presence of Zn-ions, especially in association with excessive amounts of Fe-ion, promotes the "reconversion" of $PbSO_4$ to insoluble PbS or to an insoluble basic iron-lead sulfate ($2Pb0.5Fe_2O_3.8SO_3.xH_2O$). It is further shown that PbS, in the presence of sufficient Fe-ions, can be oxidized directly to $PbSO_4$ in aqueous solution *without* acid addition giving 97-98% conversion in 8-9 hours at 140°C with 20 psi partial pressure of O_2. In the latter case pH remains at about 5.0 and little or no zinc is oxidized, nor is there any "reconversion."

Operating Controls

Monday, February 19

2:30 pm, Sky Top

Co-Chairmen: E. M. Lewis, C. H. Curtis

Elements of Dishonest Data Presentation by *James E. Lawver*—This paper deals with the pitfalls and associated misrepresentation of information when experimenters fail to use appropriate design of experiments and statistical analysis of data. The paper is deliberately slightly insulting to many AIME readers for the purpose of driving home the fact that experimental design and statistical analysis of data is as necessary in the mining profession as in any other field of modern technology.

Neutron and Gamma Instrumentation for Continuous Measurement of Moisture and Density by *O. K. Neville*—Gauges using radioactivity are playing an increasingly important role in ore handling and refining. Gamma gauges are becoming routine for providing continuous measurement and control of per cent solids in the grinding and beneficiation circuits of slurry operations. Continuous moisture measurement and control of wet filtrate is now possible by use of neutron gauges which are mounted over a conveyor belt or on a hopper. Moisture control at this point provides greater efficiency in the subsequent setup whether it involves balling leaching, sintering or smelting.

Automatic Control of Filter Feed by *George W. Sheary III*—At Bethlehem's Grace mine's 6000-tpd pelletizing plant a cascade control system is utilized to approach a constant magnetite filter cake moisture. Variations in moisture are quite critical in obtaining quality green pellets formed in the balling devices. Variables being controlled by the instrumentation are filter feed solids, filter tub level, first and second stage pump sump levels and thickener sludge level, all at varying feed rates. Startup difficulties, modifications and contemplated additions to obtain closer control of the moisture are discussed. Polyvinyl chloride piping is utilized throughout the pumping circuit because of a unique pipe line buildup. The controls are able to automatically meet the requirements of the filters and have enabled restriction of pellet plant personnel by elimination of the proposed filter operators.

Crushing and Grinding

Monday, February 19

2:30 pm, Terrace Ballroom

Co-Chairmen: J. H. Brown, J. R. Tonry

Size Analysis and Control in Nuclear Applications by *A. Beianchert.*

Grinding Iron Ore in a Wet Autogenous Mill by *Bernard Bernstrom*—A 22-ft diam, 7-ft long, wet autogenous grinding mill was installed in the new cretaceous plant of the Jones & Laughlin Steel Corp. to prepare crude iron ore for concentration in spirals and flotation cells. The paper describes the flowsheet, gives a description of the operating and metallurgical results that have been obtained. These results include capacity, horsepower, operating problems and a comparison of pilot plant results with those obtained in commercial operation.

Particle Size Measurement and Control by *Upendra N. Bhrany*—The paper presents a critical review of the problem of fracture of brittle solids and the measurement of particle size with some reference to size control in processing to achieve specified fineness.

More Accurate Grinding Calculations by *Fred C. Bond*—The present Third Theory work index equation calculates the work input required for crushing and grinding from the 80% passing sizes of the feed and product. This paper shows how the particle size distributions of the feed and product can be used with the 80% passing sizes to obtain constant work index values for different product sizes and more accurate power calculation results.

The size distribution criterion is the exposure ratio, obtained from exponential semi-log plots of the screen analyses of feed and product. These plots also indicate natural and induced grain sizes, and furnish more accurate 80% passing sizes in microns.

Size Control in Southwest Copper Plants by *H. K. Burke* and *Russell Salter.*

Particle Size Analysis in Portland Cement Manufacturing by *E. S. Porter*—Particle size information is required in the manufacture of portland cement in order to regulate grinding operations, control the efficiency of the burning process and provide proper control of the hardening characteristics of concrete. Specifications for portland cement include minimum values of fineness, or specific surface. The two standard fineness test methods are the Blaine air permeability test and the Wagner turbidimeter. The Blaine test measures specific surfaces by flow of air through a packed bed of powder. The Wagner turbidimeter follows Stokes' law for particles settling in a fluid, and measures concentration of particles at a specified level in a settling chamber by light reflection. Both standard tests utilize a standard cement sample for instrument calibration.

The air permeability test, combined with standard sieves for coarse particle control, is the major size control method used in the industry. Size distribution information is obtained from Wagner fineness tests, or with air classifiers, or standard sedimentation techniques. A centrifugal particle size analyzer has been utilized for research purposes at the Portland Cement Assn. laboratories. Electronic particle counting has recently been utilized by the industry, and may further advance the high degree of automation in modern cement plants.

Mill Design

Tuesday, February 20

9:00 am, Sky Top

Co-Chairmen: F. J. Windolph, R. L. Druva

Tunnel Reclaim Systems for Bulk Products by *Leo Borasio* and *Svend A. Ronlov*—Previous papers by other authors have discussed the various types of structures utilized by bulk product producing companies (such as potash) for storing their products. This paper presents methods of reclaim utilized in this field and particularly discusses a new method presently being designed with emphasis on the aspects of design evolution for the machinery and structure involved from initial concept to final development.

The Atlantic City Story by *S. H. Cohlmeyer*, *A. S. Henderson* and *R. C. Morgan*—The authors describe the exploration, development, engineering considerations and current construction status of the Columbia-Geneva Steel Division taconite iron ore facility in Wyoming. The mine, mill and agglomerating plant will produce iron ore pellets for the Division's Geneva Works at Provo, Utah. Special note is made of the engineering requirements peculiar to the plant location, including water development, power and fuel supply and major rail construction.

Maintenance Problems at Mines Development Inc., Edgemont, S. D. by *E. W. Davis*—The problems involved in introducing new and improved materials into plant service are discussed. Specific examples are given to show how newly developed materials can eliminate maintenance problems in corrosive situations. The use of PVC and fiberglas in Mines Development's Edgemont plant are described in detail. A planned program for investigating the use of new materials is discussed.

Design Engineering and Technical Assistance on Construction and Operation of the Sang Dong Chemical Plant in the Republic of Korea by *Earl O. Torgerson* and *Chae Hwan Lee*—A description of the general contract work phases: design, construction, start-up of operations and training under a technical-advisory type contract between Utah Construction & Mining Co. and the Korea Tungsten Mining Co.

Materials Handling and Storage

Wednesday, February 21

9:00 am, Sky Top

Co-Chairmen: D. Carlson, W. Arpi

Uses of Glass Reinforced Plastics in Western Metallurgy by *Robert W. Burns*—Possibly no single material has aroused so much controversy as has glass reinforced plastics. This paper seeks to "clear the air" in regard to uses of glass reinforced polyesters and epoxies.

Dealing primarily with past uses of these materials in Western metallurgical operations, the paper equally outlines both failures and past successes and gives reasons for success or failure.

Since causes of failure are found largely in ignorance of the properties of resin/glass laminates, the paper delves into methods and reasoning in making a proper material choice. In this regard, the engineering characteristics and techniques of glass reinforced plastics are discussed. Methods of application, as relates to chemical and physical properties of the finished products, are discussed, with suggestions for the writing of dependable specifications offered.

Throughout, the paper documents specific case histories, both good and bad. Though noted for many failures, the author attempts to point out that these failures were the result of incompetence, misunderstanding or of poor earlier techniques, and were entirely predictable in light of present day knowledge of the products.

A Three Dimensional Belt Conveyor by *Gerd Klinkenborg*—The Serpentix is a multi-directional conveyor, capable of horizontal curves in either or both directions, within a radius of 10 ft. In addition, it is capable of vertical curves as heretofore unattainable angles of incline. Further, the belt's flexibility makes possible the separation of the top from the return so as to permit use of both for the transport of material. The design permits the installation of a top-running belt, capable of traveling in an almost complete horizontal circle, and facilitating the use of the entire belt surface except for the immediate vicinity of the drive. The discharge of material is not limited to "over the head," but rather, by means of a control turning of the belt, material may be discharged sideways at any predetermined point or points along the route. The Serpentix is an endless conveyor belt, consisting of guided roller carriages, fastened to a flexible pulling element to which a rubber belt is attached. The rubber belt acts as the carrying surface, and its exclusive folded design, with folds across its entire width, permits passage through steep inclines with no "roll-back" loss. These same folds impart the flexibility and stretchability necessary to permit twisting and turning. The belt may be made of fiberless rubber for greater wear and longer life, because the entire pulling load is absorbed by the pulling element. In most installations this element is a round-link chain driven by a sprocket drive wheel.

Accurate Mixing of Sized Materials by *Edward P. Larsen*—This paper covers a description of a centrally controlled system for the

(Session continued on page 1254)

accurate assembly of different sizes of material to meet the widely varying demands of specifications for aggregate and other material mixtures.

Deep Well Construction for the Disposal of Uranium Mill Tailing Water by The Anaconda Co. at Grants, N. M. by *R. D. Lynn* and *Z. E. Arlin*—A deep well injection system is used by The Anaconda Co. for the disposal of uranium mill tailing water near Grants, N. M. A 2511-ft hole was cored and tested through Triassic, Permian and Pennsylvanian (?) sediments and bottomed in Precambrian granite gneiss. The disposal well was plugged back to 1830 ft and completed in 563 ft of sandstones in the Yeso formation. The reservoir sandstones contain water similar to the injected waste water, and are isolated from overlying fresh-water aquifers by an evaporite barrier zone.

Mill tailing water is decanted, filtered and introduced into the well by gravity at an average rate of 500 gpm. The reservoir has a life expectancy of 100 years.

Liquid Sulfur Transportation and Storage by *J. E. Monroe, Jr.* and *F. L. Jackson*—The large-scale transportation and storage of liquid sulfur, a relatively new development, has grown rapidly during the past year. By receiving liquid sulfur rather than the traditional broken solid form, the consumer reduces or eliminates labor costs, losses, dust nuisance and, at the same time, receives a product with virtually no contamination.

Providing handling and storage systems are properly designed, there is less danger of fire with molten sulfur than with the solid. Because virgin liquid sulfur in the absence of moisture can be handled in mild steel, equipment is relatively simple. However, certain precautions must be taken in designing and operating liquid sulfur storage and handling facilities to insure safe, trouble-free performance. Although liquid sulfur usually contains traces of H_2S, storage tanks can be designed and operated so as to avoid the build-up of explosive atmospheres. Minimizing agitation and providing adequate ventilation have proven effective. Explosion meters have been tested in an explosion pilot plant, and are used for monitoring the atmospheres in storage vessels.

Liquid sulfur is shipped by truck, rail, barge, tanker and pipeline. It is stored in concrete pits and storage tanks of up to 12,000 long tons capacity. A number of types of valves and pumps are used, but in all cases adequate means of heating should be provided. Heating of tanks, valves, lines, pumps, etc. is accomplished by steam or hot oil, either in tracers, jackets, gut lines or coils.

Pneumatic Conveyors—Their Application in the Minerals Industry by *H. A. Stoess, Jr.*—Pneumatic conveyors are being used more extensively throughout the industry today to reduce labor costs. Also, economical in-plant materials handling is conducive to the lowering of the costs of the ultimate product. For this discussion, these conveyors are classified into their respective uses in the mineral industry. The discussion includes the application of the various types of pneumatic conveyors to the industry together with their advantages and disadvantages.

Concentration (Joint with IndMD)

Wednesday, February 21

9:00 am. See p. 1252.

Basic Science (Joint with EMD and ISD)

Wednesday, February 21

9:00 am, Gold Ballroom

No information available at this time—see January issue.

Concentration

Wednesday, February 21

2:00 pm, Sky Top

Co-Chairmen: C. Komadina, B. C. Mariacher

Liberia Mining Co. Ltd. Operates Iron Ore Beneficiation Plant by *Dunston F. Boyd*—The article is a summary of the flowsheet used by Liberia Mining Co. Ltd. to treat its iron formations that overlay the direct shipping ores. Location is at Bomi Hills, Liberia. In addition to flowsheet analysis, the author points out many features of the plant operation which include the flexibility to handle a variety of ores through a relatively simple combination of gravity separations. The process employs use of the counterflow sizer cleaning a coarser finished concentrate from the rougher spiral concentrate. Its operation, advantages and disadvantages are discussed in detail in relation to the Bomi Hills ore.

The operating staff has had many problems to solve to produce 100,000 long tons of 65% Fe per month. Down time has had to be kept to a minimum through careful maintenance and protection against abrasion. Rubber lining of pumps, launders, transfer points and tailings flume have successfully halted most of the wear. Continual supervision and adjusting to the ore aid in obtaining the highest possible recovery. Recent flowsheet changes and their operation including installation of DSM screens ahead of the rougher spirals are included to bring the article up to date.

Kinetics of Flotation by *C. H. G. Bushell*—The author maintains that selectivity in flotation depends in part on differences in rates of flotation. The rate of flotation should be directly proportional to the frequency of particle-bubble collisions. In this paper, it is suggested that floatable particles of the mineral must be distinguished from non-floatable particles.

Converting Gravity-Flotation Plant to All-Flotation by *H. A. Hoffman*—Two significant changes occurred in the Lead Belt in recent years to permit all-flotation milling to be seriously considered. One was a change in the smelting contract, which did not require gravity concentrate, and the other was the development of cyclones for classification in a small area.

Laboratory testing indicated that significant tailing improvement could be obtained. Estimates of manpower reduction of some 30% also was instrumental in giving all-flotation milling very serious consideration.

One section of the five at the Federal mill was made available for separate testing of all-flotation. The results confirmed laboratory findings. Studies were made for conversion of the entire mill to all-flotation. This conversion hinged on the incorporation of two by-products in the flowsheet. One was the successful production of agricultural limestone to specifications, and the other was the recovery of copper from a bulk lead-copper concentrate. Test work indicated both could be successfully incorporated in the all-flotation flowsheet. Conversion began on June 27, 1960 and was completed Feb. 20, 1961. The mill operated continuously during this conversion. It has proven successful with results rapidly approaching laboratory estimate.

Dry Autogenous Grinding and Dry Magnetic Concentration of Iron Ores by *R. R. Janes* and *F. Everard*—Pilot plant studies have been conducted on a variety of iron ores of varying composition and grain size to test their amenability to dry autogenous grinding and dry magnetic concentration. A general description of the pilot plant and its equipment is given with particular reference to the Aerofall mill and the dry magnetic separators developed by the Ontario Research Foundation. Test results are reviewed in detail with emphasis on power consumption, mill speed, the use of ball charges, types of ores, moisture content, separator speeds and design. A list of references is provided.

Pyrolysis and Agglomeration

Thursday, February 22

9:00 am, Sky Top

Co-Chairmen: William Stowasser, J. E. Stukel

Stationary, Cross-Blown Sinter Cooler, by *F. P. Howald* and *F. W. Kinsey*—A forced draft sinter cooler designed and constructed so as to have no moving parts in contact with the cooling sinter has been installed at the Benson mines, New York facility of the Jones & Laughlin Steel Corp. The cooler is fed from two 616-sq ft machines that sinter a magnetite concentrate. The operation of this cooler was investigated to evaluate its performance a short time after the unit was placed on stream. This investigation was designed to characterize operation of the cooler thermally and mechanically and to evaluate the quality of the sinter produced. Quantitative data are presented to characterize performance with respect to these criteria. Heat balances for various air flows and sinter throughputs are included, and general observations are presented on cooler performance from an overall operations viewpoint.

A Treatise On Design Evolution of Vertical Shaft Furnace by *A. W. Storm*—A short review of shaft furnace design and operation from prerecorded history to the late 1940's followed by a more comprehensive record of furnace development from 1950 to date. The several fundamental types of shaft furnace configurations are described and discussed with the pros and cons of operation, control and relative economies of each compared. The theory of operational control of today's magnetic pelletizing furnace is presented, augmented with current commercial performance data.

Operating and Startup of the Humboldt Pellet Plant by *D. M. Urich*—The paper covers the main features of operating the Humboldt Pellet Plant. The pelletizing system (grate-kiln) represents the first commercially sized units built for the pyro-processing of iron ore pellets. Raw materials handling, material storage and preparation, pelletizing, air handling and dust collection, reclaiming and accessory equipment are listed and their functions detailed. Training of personnel for the plant startup is explained and the method of plant startup is detailed. Heat requirements, product quality and capacity of each unit is discussed and reviewed.

Solids-Fluid Separation

Thursday, February 22

2:00 pm, Sky Top

Co-Chairmen: D. C. Matthews, W. C. Mason

Clarified Solutions by Reversible Cake Filtration by *Judson G. Brown*—Reversible cake filtration with its self-plugging backwash feature was originally developed for use in the mining industry. It should be considered for most feeds containing less than 1% suspended solids and in some cases up to about 5% suspended solids. A ⅛ in. thick cake is considered to be very thick with a 1/32 in. thick cake normal. Solids of an average particle size of 20 microns and non-compressible are considered very easy to filter.

A new line of injection molded plastic filters was developed for this process. The first installation was made in February 1959. Recent sales include a paper mill, a chemical company and a mining company.

Breaking Emulsions with Corona Discharge, by *John L. Carswell*—The corona discharge which results when a potential of several thousand volts is applied to a pointed electrode may be used to supply a considerable charge to the surface of a dielectric liquid. If a grounded electrode is immersed in the liquid, an electrical field exists between the surface and the grounded electrode, and forces are applied to charged particles suspended in the liquid. Emulsions of many immiscible liquids in which the continuous phase is a dielectric may be broken almost instantaneously by the application of a corona discharge. The primary application, that we have found so far, is the treatment of water-oil emulsions in the production of crude petroleum. Field tests have proven that this process can produce cleaner oil at less cost than the standard method of chemicals and heat. Oils may be cleaned by forming an emulsion with fresh water and breaking the emulsion with corona discharge. Soluble salt and acids and some solids may be removed in this manner.

Sedimentation Process Fundamentals by *Bryant Fitch*—There are three regimes of sedimentations, namely clarification, zone settling and compression thickening. Any one may be limiting, and all three must be taken into account in specifying equipment dimensions. The characteristics and critical design factors of each are reviewed.

Thickeners—New Concepts in Mechanism Designs, Underflow Pump Arrangement and Automatic Controls for Optimum Thickening of

Metallurgical Slurries by *Donald L. King* and *Berne A. Schepman*—A number of unique thickener mechanism designs are discussed with the operating results achieved in various installations. These unusual designs include new types of raking arms, lifting devices and feedwells employed to obtain higher underflow densities and minimum operator control or improved overflow clarity. Several installations of large thickeners in which the underflow lines pass upward through the center to eliminate tunnels are reviewed. The location of the lines and pumps with the maintenance and operating records are included. Several types of automatic lifting device controls are used to provide storage in the thickener. Some of the installations employing underflow density controls are achieving excellent operating results.

Handling of Iron Ore in a CCD Thickener Circuit by *O. J. Malacarne* and *D. G. Millinbruch*—The handling of total ore in CCD thickener circuit involves refined methods of controlling underflow density, ore-flocculent mixing and slimes settling rate. A description of these features is presented for the CCD circuit at the Union Carbide Nuclear Co. uranium mill at Uravan, Colo. The circuit utilizes nuclear gauges to control underflow density, two automatic methods of controlling settling rates and modified center wells to promote ore-flocculent contact. Operational features included are maintenance experience, performance and characteristics of operation.

Slime Removal from Mill Solutions by Froth Flotation by *Fred N. Oberg* and *Clyde N. Garman*—Unsettleable slimes in two separate sections of a carbonate leach uranium mill caused operating difficulties. Removal of the offending slimes by froth flotation proved feasible and much more economical than other procedures considered, such as precoat filtration or sand filters. Various new organic reagents have been tried with varying degrees of success. Animal glue and creosote serve as promoters. Effectiveness of reagents is determined more often by light transmission or color than by filtration and weighing of the residue.

An Analysis of the Wash Thickener-Two Stage Filtration Circuit by *Robert S. Olson*—The operation of a series wash thickener-two-stage filtration circuit determines the soluble loss in many hydrometallurgical operations. A study of this circuit yielded expressions which permit calculation of soluble loss for almost any condition of operation. The soluble loss over a range of circuit variables is presented. The interrelation of factors affecting filter performance and some of the wash circuit variables are quantitatively described.

Filter wash, which is governed by wash zone size, filter pulp level and filter feed pulp density, has the greatest effect on soluble loss. Excepting clothing binding and flocculation, the factors which decrease filter capacity also decrease soluble loss. Repulping with water, under some circumstances, can be an important means of soluble loss reduction. Water for primary filter wash, leach pulp density, repulp density and wash thickener underflow density have little effect on soluble loss. The dilution of both the filter feed pulps with wash solution, is suggested as a means of reducing soluble loss and, at the same time, controlling the performance of the filters. Blowback and filter cloth blinding seriously increase soluble loss.

Dewatering and Processing of Kaolin Clays by *William M. Phillips*—This paper outlines the general processing methods for kaolin clays starting at the mine and ending with the finished product. Particular emphasis is given to the dewatering of the extremely fine clay particles. In the proper processing sequence, the following steps are described in detail: 1) gravity dewatering and settling in tanks or thickeners, 2) centrifugal dewatering and classification with solid bowl and nozzle type centrifuges, 3) dewatering with continuous rotary vacuum filters and filter presses and 4) thermal drying with double drum dryers, spray dryers, rotary dryers and apron dryers.

MINING & EXPLORATION DIVISION

Open Pit Mining

Monday, February 19

9:30 am, Georgian Room

Chairman: M. Hannifan

Trend to Larger Haulage and Excavating Equipment in Open Pit Mining by *George W. Parker* and *John F. Dougherty*—This paper deals with the trend to larger haulage and excavating equipment in open pit mining. With the constant increase in cost, operators are looking for methods of reducing costs, and one logical way is to use larger equipment. As operations grow, or as new operations start, the indicated trend is toward the use of larger haulage and excavating equipment. Mention is made of what the manufacturers have available and what they are planning in larger equipment.

Specific details are given on the operation of the 15-cu yd shovel and 60-ton trucks used in Anaconda's Berkely Pit contractors stripping operation. Mention is made of ripping vs. drilling and blasting, citing Anaconda's open pit operations at Grants, N. M.

Let's Reduce the Noise from Blasting by *James A. Todd, Jr.*—Blasting complaints are related to the amount of noise produced from the blast, and reduction of this noise will do much to reduce complaints. General rules can be established with regard to favorable weather conditions and the effect upon sound return. These conditions can be interpreted in regard to those that are generally favorable or unfavorable for blasting. Blasting only on those days that have favorable weather conditions will do much to take the noise out of blasting.

Atmospheric Affects Upon the Propagation and Attenuation of Sound and Shock Waves by *John E. Wallace*—In normal atmosphere, structure, sound and shock waves emanating from a source of the magnitude attained in quarry blasting are reduced to harmless quantities a few hundred ft from quarry. This is because in a normal atmosphere temperature decreases with altitude, and consequently, sound and shock waves are reflected upward in the atmosphere. When temperature increases with altitute, just the opposite affect is accomplished and sound and shock waves are reflected downward, reaching the earth with a high percentage of their source magnitude under extreme conditions. Sheer in the winds aloft, and also humidity, is a factor affecting the reflection of sound and shock waves in the atmosphere. The presence of temperature inversions (increases of temperature with altitude) are most readily ascertained by atmospheric soundings. Temperature inversions may also be determined, qualitatively at least, by several visual observations from ground level. Most complaints from blasting operations can be eliminated by the application of meteorological information in daily planning.

Underground Mining

Monday, February 19

2:30 pm, Georgian Room

Chairman: J. B. Elizondo

The Sinking of a Circular Shaft at White Pine, Mich. by *C. S. Boland* and *H. G. Young*—During the latter part of 1960, Boland Development Co. Ltd. of Toronto, Ont., contracted to sink a 20 ft diam concrete-lined mine service shaft, 2250 ft deep, for the Copper Range Co. at White Pine, Mich. This contract also included design and construction of a temporary surface plant for shaft sinking and initial mine development. South African sinking practices, modified to suit local conditions and the specific requirements of the job, were used. This paper describes the surface plant, facilities and methods employed in executing the various phases of the project.

The Underground Use of Ammonium Nitrate-Fuel Oil Explosives at St. Joseph Lead Co. Operations by *L. W. Casteel*—This is not a scientific treatise concerned with the physical and chemical parameters of ammonium nitrate-fuel oil explosives. It is a paper dealing with the practical aspects of introducing and using AN-FO in a hard rock mine in holes as small as 1¼ in. in diam. It refutes the commonly accepted ammonium nitrate myths of bad fumes, static electricity and improper detonation in small holes. It describes the development of a small, one-man pneumatic placer that made the use of AN-FO feasible in small, widely scattered stopes.

Rubber-Tired End Loader Application, Illinois-Wisconsin Operations, The Eagle-Picher Co. by *Robert L. Haffner*—The present application of rubber-tired end loaders, as an integral part of the trackless mining method in use, is discussed in detail. Emphasis is placed on the background data and problems which resulted in the choice of this method of loading along with information relative to the equipment selection. The importance of the careful operator and maintenance crew training is presented as a key to the successful application of this equipment. The use of larger haulage trucks in the shaft mines and inclined adit operations is offered as a means of realizing a greater potential from present end loader equipment.

Some Application of the Undercut-and-Fill Mining Method by *J. A. Pigott* and *R. J. Hall*.

Investigations of the Influence of Block Caving Upon Adjacent Mine Openings by *Stephen Utter* and *Robert L. Bolmer*—When mine workings are damaged by rock pressures induced by block caving, the mining cost increases, production decreases and ore recovery may be considerably lessened. Development of improved designs and methods for reducing this damage requires an understanding of: 1) the stress concentrations around the openings and the changes created by adjacent mining; 2) the physical properties of the rock surrounding the drifts; and 3) the support supplied by the concrete lining or other supporting members in the drifts. This discussion summarizes the results of preliminary investigations concerning the influence of block caving mining operations upon adjacent mine openings. This investigation is one part of a general study of the rock mechanics of block caving being performed by researchers in the U.S. Bureau of Mines.

The stress concentrations induced in the rock and in the concrete surrounding the mine openings were estimated from measurements of strain and deformation. The instrumentation and procedures are briefly described. The stress concentrations induced by block caving mining are compared with stresses predicted from the theory of elasticity and the agreement noted. Methods of reducing the stress concentrations and, hence, increasing the stability of these openings, are described.

Geological Engineering

Tuesday, February 20

9:00 am, Georgian Room

Co-Chairmen: J. M. Neilson, M. Nackowshi

Fractors Influencing the Breakdown of Carbonate Aggregates During Field Compaction by *N. B. Aughenbaugh, R. B. Johnson* and *E. J. Yoder*—Mineral aggregates experience degradation during field and laboratory compaction. This reduction in the aggregate size is accompanied by abrasion of the particle edges and/or fracturing of individual pieces which have become overstressed. Very little is known of the factors that govern the amount of breakdown experienced for a given situation.

A field study was made of the factors affecting aggregate breakdown under compaction using three carbonate aggregates of different physical properties. The preliminary results indicate that rock type, compactive effort, gradation and thickness of the compactive layer are the factors which exert the greatest influence.

The Analysis of Structural Patterns in Bedrock by *Peter C. Badgley*—Fracture patterns are well developed in the bedrock of most regions. Many theories have been suggested for their mechanics and time of origin, but general agreement has not been reached. This report examines fracture patterns in several structural settings, including foreland uplifts, basinal rims, foothill disturbed belts and mineral districts. Some of these patterns have been reproduced experimentally. The conclusion is reached that fracture patterns do give direct evidence concerning the nature and timing of tectonic stresses. Of special interest is the evidence which they provide on some of the controversial aspects of mountain building.

Bedrock Geology and Topography of the Coastal Plain Near Princeton, N. J.—A Geological Engineering Case History by *William E. Bonini*—This paper is a summarization of a coordinated effort

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using geological, seismic, electrical, gravity and magnetic techniques to work out the bedrock topography and lithology of a 25-sq mile area of the Coastal Plain near the fall line in central New Jersey. The results show the pre-Raritan (Cretaceous) drainage pattern with local relief of over 100 ft, and aid in the interpretation of the pre-Pennsauken (Pleistocene) and recent erosional surfaces. The work indicates pre-Raritan valleys which may contain hitherto unknown aquifers. The seismic velocities combined with gravity, magnetic and well data permit the delineation of the crystalline and Triassis bedrock areas.

Subsurface Investigations by Seismic Refraction by *Eugene A. Hickok*—Geophysical Specialties Co. has performed contract seismic refraction surveys since 1957 in many parts of the U.S., Canada and several foreign countries. These surveys, utilizing the Model MD-1 engineering seismograph, have proven the refraction seismic technique to be applicable to a wide variety of engineering problems.

This discussion describes the use of the single trace refraction seismograph method for the delineation of material and mineral deposits, and its usefulness in water supply and foundation investigations. Examples of seismic surveys for different engineering purposes are given and conclusions are drawn regarding the capability and limitation of the seismic method for each application.

Geological Aspects of Construction of the Harold D. Roberts Tunnel by *Ernest E. Wahlstrom*—The Harold D. Roberts tunnel, in Summit and Park Counties, Colo., is a concrete-lined pressure tunnel finished to a circular cross-section of 10.25 ft diam. The tunnel is 23.3 miles long and is designed to transport water for domestic use by the City and County of Denver from reservoir storage at Dillon to a tributary of the South Platte River at Grant. The tunnel passes beneath the Continental Divide at the crest of the Front Range and intersects rocks of diverse types and origins and geologic structures of extreme complexity.

Geologic investigations preceded and were continued during construction and contributed materially to the safe and economical advance of the tunnel headings. Geological data obtained and evaluated during construction include plans and sections on a scale of 1 in.: 50 ft, rock temperatures at 2000-ft intervals, records of progress related to geology, records of ground-water conditions, summaries of the use of steel and timber supports and summaries of grouting operations.

Epigenesis vs Syngenesis (Joint with SEG)

Wednesday, February 21

9:00 am, Georgian Room

No information available at this time—see January issue.

Jackling Lecture Session

Wednesday, February 21

2:00 pm, Georgian Room

Mine Management by *Gloyd M. Wiles.*

Major and Minor Elements in Host Rocks (Joint with SEG)

Thursday, February 22

9:00 am, Georgian Room

Co-Chairmen: R. J. Lyon, H. Bloom

Some Compositional Effects of Hydrothermal Alteration by *C. Wayne Burnham*—The vast majority of hydrothermally altered rocks are readily grouped into three principal facies: the propylitic, argillic and phyllic (mica) facies. The argillic facies comprise the montmorillonite and haolinite subfacies, and the phyllic facies the muscovite and biotite subfacies. The characteristic mineral assemblages of the propylitic facies are conveniently represented on a standard ACF diagram, and those of the other facies on AKF diagrams to which water (H) has been added.

Generally each facies characterizes a zone of alteration that bears consistent relationships to neighboring zones and to a presumed source of heat and altering fluids. These relationships also are in full accord with the inferred physical-chemical requirements of the corresponding facies.

The upper limits of thermal stability for the different facies at 1000 bars water pressure are fixed by the breakdown temperatures of individual minerals-epidote at about 460°C for the propylitic facies, kaolinite at 400°C and montmorillonite at 420°C for the argillic facies, and muscovite at about 620°C for the phyllic facies. Biotite of the phyllic facies is stable well into the melting range of granitic rocks.

Adirondack Orogenesis and Mineral Deposits by *A. E. J. Engel* and *Celeste G. Engel*—Important concentrations of magnetite, sphalerite, galena, talc, feldspar and dolomite have formed during orogenesis in the Northwest Adirondacks, N. Y. These deposits are partly derived from, and emplaced in, a billion year old sequence of graywacke, basic-volcanic and siliceous dolomite.

During orogenesis the more deeply depressed segments of the sequence were dehydrated, decarbonated, reduced and partially melted at temperatures of some 600° to 900°C, at depths up to 15, possibly 20 miles. Principal anatectic magma, enriched in H_2O, Si, K, Ba, Mn, Pb and Zn, was derived from the graywacke where incipient melting began at 600°C. Additional H_2O and K were released during the reconstitution of the volcanics. The siliceous dolomite was profoundly decarbonated.

These H_2O, CO_2, alkali-rich fluids, augmented by granitic magma derived from even deeper orogenic roots, moved upward and outward into cooler parts of the sequence leaching from it large volumes of Fe and Mg. Ultimately, these elements, along with K, Ba, Mn, Pb and Zn, were precipitated in both concentrated and disseminated form.

The principal mineral concentrations include skarns, talc belts, pegmatites and sulfide veins. Ore-forming constituents thus have a composite origin; from subjacent parts of the host rock and from underlying segments of sial, sima and possibly mantle. The basic causes of orogenesis, and the proportions of constituents from the several sources, remain conjectural.

Mg/Ca Ratios in Carbonate Wall-Rock by *M. A. Klugman, D. N. Bloom* and *D. N. Stevens*—Dolomitization of carbonate host-rocks near mineralization is a well-known phenomenon. However, the extent and intensity of such dolomitization about specific deposits can seldom be detected by ordinary field methods, especially where a regional dolomitic background exists.

This paper concerns four Zn-Pb ore-bodies in the Alma-Horseshoe mining district of Colorado. Two deposits are in Leadville limestone, known to be dolomitized throughout the district; the others are in the Manitou and Peerless dolomites. All four deposits show a general increase in the Mg/Ca ratio of the carbonate host approaching mineralization. For example, a 25-ft wide orebody is detectable 120 ft into the country rock by this technique, suggesting a primary halo of increased dolomitization about the ore.

Different beds within a single formation (e.g. Leadville limestone) show no significant variations in the Mg/Ca ratio. Changes in lithology, however, notably influence the results; present research is directed toward countering this effect.

Samples were taken from long-hole drill cuttings and mine workings extending from ore-zones into wall-rock. Ca and Mg were determined by standard EDTA procedures involving titration at appropriate pU levels. This method is rapid, economical and can easily be carried out in a field camp.

Compositions of Sandstone Host Rocks of Uranium Ores by *A. T. Miesch*—Uranium deposits on the Colorado Plateau are contained in fine-grained orthoquartzites, feldspathic and tuffaceous orthoquartzites and conglomeratic arkose. The average chemical compositions of these rocks are not notably different from published average sandstone compositions.

Elements that have been introduced into the uranium ores by mineralization processes (extrinsic elements) can be identified, and estimates of the introduced or extrinsic amounts can be made by comparison of the composition of the ores with the composition of the host rocks. Examination of the geology, distribution and compositional variation of uranium deposits on the Plateau provides evidence pointing to the host rocks as a possible source of at least some of the intrinsic elements.

Some correspondence has been found between the compositions of sandstone host rocks and the compositions of uranium ores from the host rocks, but the correspondence is not pronounced. Nevertheless, the extrinsic amounts of most elements in the ores could have been derived from the sandstones within a few hundred ft of the deposits without reducing their concentrations in the sandstones by detectable amounts. Uranium and probably vanadium, however, must have been derived from greater distances.

Redistribution of K, Na and Al in Some Felsic Rocks in Nevada and Sweden by *Donald B. Tatlock*—Rhyolitic rocks of the Permian and Triassic Koipato Group in northwestern Nevada, originally aggregating at least 1000 cu miles, were derived from a magma which crystallized as a leucogranite containing 5.87% K_2O, 3.0% Na_2O, 12.0% Al_2O_3. It is hypothesized that ubiquitous albitization of approximately the lower half of the volcanic pile, whose composition was that of the leucogranite, began early in the eruptive period. The upper half was derived from a later potassic differentiate (6.8% K_2O, 1.2% Na_2O) of the leucogranite magma. K-rich fluids associated with the potassic differentiate infiltrated the pile including previously albitized zones as well as parts of the leucogranite pluton, accomplishing a nearly pervasive replacement of albite by K-feldspar. The effect was to greatly enrich the pile in K at the expense of Na; an estimated 40% of the pile contains 6.0% to 13.0% K_2O and 0.5% Na_2O. Local redistribution of alkalis was a minor process.

A later redistribution of K and Al within the altered pile was accomplished by fluids associated with the intrusion of Cretaceous quartz monzonite, producing zones of sericite and pinite and locally large bodies of andalusite and/or pyrophyllite. Andalusite-pyrophyllite and feldspar are everywhere mutually exclusive.

A similar but more general picture of the mobility of alkalis over a large area is suggested from a study of 846 analyses of Swedish rocks, mostly from mining districts. 25% of the metamorphic rocks, mostly felsic granulites, and 10.5% of the igneous (?) rocks have extreme alkali ratios with Niggli k-values of less than 0.1 and greater than 0.7; rocks rich in K predominate by 3 to 2, and most are peraluminous.

Geophysics

Thursday, February 22

2:00 pm, Georgian Room

Chairman: D. F. Coolbaugh

Some Aspects of the Economics of Ground Geophysics by *Thomas Cantwell*—In deciding whether to use ground geophysics and in choosing a geophysical method, a number of economic factors are involved. Each type of mining problem from exploration to mine development has different economics. Using as a common ground the maximization of profit, a general approach to this decision problem is developed. Case studies involving induced polarization and magnetic measurements will be given. Although this approach is fruitful in aiding a decision, the limited data available usually do not point to a definitive solution.

COUNCIL OF ECONOMICS

Mineral Imports and Stabilization Policy

Monday, February 19

2:30 pm, West Room

Canadian View of the Lead-Zinc Quota Problem by *G. A. Gordon*—A review of political and economic relations between Canada and the U.S.: the flow of mine production between the two countries, Canada's position as a buyer and seller in world markets and current and long-range effect of the U.S. lead-zinc quota on Canadian mining operations and trade relationship.

Problems in International Copper Stabilization by *Robert G. Page*—"International copper stabilization" is assumed to mean control of rates of production, exports and imports, with a view to maintaining a price for the metal "fair" to producers and consumers. Some consumers and some producers, particularly those in countries whose economy depends to an important degree on copper, have from time to time expressed an interest in "stabilization". While one may sympathize with their efforts to avoid the effect of a constantly changing supply-demand relationship, there is little in the history of previous efforts at stabilization to give hope that a new program would be satisfactory.

American and American-controlled production cannot legally become a part of any such program unless the program is authorized and administered by the governments concerned, including the U.S. Government. It may well be doubted whether an inter-governmental board would be able to improve on the record of private groups made during similar attempts in the past. Given the vital role that primary production plays in the economy of various Latin-American and African countries, moreover, such a program could well threaten grave damage to the domestic industry in view of our announced policy of assistance to such foreign countries.

The history of the last two years would seem to indicate that it should be possible, without a stabilization program, to avoid the wide swings in price which have formerly plagued the industry.

Impact of 1960-61 Developments on Foreign Investments

Tuesday, February 20

9:00 am, West Room

The Impact of International Developments in 1960-61 on the Investment Climate in South Africa by *M. D. Banghart*—This paper discusses mining developments and investments in the Republic of South Africa and in the mandated territory of South West Africa during the past 50 years, and gives the author's opinion of the impact of international developments by African anti-colonialism on existing mining operations and the influence of these developments on future mining operations in southern Africa. Details of plant and mine expansion underway at properties in which Newmont Mining Corp. is financially interested are given.

Mining Trends in Latin America—Restrictive Policies Slow Developments by *William F. Butler*—Latin America plays an important role in the world nonmetallic mining industry. The area's exports exceed $1 billion a year, and it is a significant factor in 16 metals or ores. U.S. private capital has financed a major share of mining operations in Latin America. Total U.S. private investment is well over $1¼ billion. These U.S.-financed mining operations make a most significant contribution to the economies in which they operate.

However, trends in recent years, and particularly in 1960 and 1961, have moved in a direction that inhibits both the full development of Latin America's vast minerals resources and the flow of these products into world markets. Economic, social and political factors have been moving along lines that are increasingly nationalistic and restrictive.

All of this poses great challenges to those concerned with the well-being and progress of the free world. If the free world is to prosper and advance, it must maintain and foster an economical private mining industry—for mining is the most basic of all industries. Such an objective can be obtained only by broadening the horizons of national economic policies relating to mining.

The Impact of International Developments During 1960-1961 On Foreign Investments by *Northcutt Ely*—International developments in 1960-1961 foreshadow a braking on American investment abroad, which by 1960 amounted to more than $30 billion, of which petroleum and mining outlays constituted over 40%. Two key factors dominated these developments: nationalism and the cold war. Heightened nationalism was significant in two respects. First, transition in the "emerging" nations was marked by turmoil in some instances, thus posing serious deterrents to investments in those areas. Second, increased expropriation of foreign property and more stringent policies with reference to foreign investments threatened to curtail investment in other areas.

Decreasing nationalistic trends were evidenced in the growth of multination trading blocs, illustrated most significantly by Britain's decision to join the European Common Market. The consequences to foreign investment in those markets remain uncertain at this point, though there are signs of increased investment in the European Common Market area.

The cold war continued to affect all phases of international economic activity. The new Administration's proposals for increased foreign aid rekindled the controversy over whether our foreign aid program is incompatible with efforts to stimulate investment abroad. Our mineral imports program continues to be guided by national security considerations. Russia's continued glutting of world markets with certain commodities below established world prices threatens foreign investment dependent on those markets.

Forecast of U.S. Fuel Requirements

Wednesday, February 21

9:00 am, West Room

Future Nuclear Fuel Requirements by *Richard R. Tarrice*—A relationship is established between nuclear power capacity, generation and raw material requirements. The potential rate of capacity additions and related inventories is compared with nuclear fuel consumption. Nuclear fuel resources and current supply capability are discussed. The effects of various types of nuclear power systems and anticipated technological improvements on the need for raw materials are reviewed. Major segments of the nuclear fuel cycle are described. A forecast of future nuclear fuel requirements is presented. Key references concerning nuclear fuel matters are provided.

Operations Research in the Mining Industry

Wednesday, February 21

2:00 pm, West Room

Activity Analysis of Mineral Exploration and Allocation by *Merih Celasun*—A dynamic programming model is developed to analytically cope with the hierarchy of sequential decision problems encountered in mineral exploration. Exploration managers are normally faced with situations where the exploration efforts need to be adjusted periodically to best serve the competing demands for a broad range of alternative activities such as prospects, examinations and projects, with different operational, economic and speculative characteristics. Since the optimization of the outcome of one activity may result in the sub-optimization of all the others, it becomes highly desirable to have a sequential scheme, such as dynamic programming, to determine approximately optimum over-all policy for exploration. Several measures of effectiveness are postulated, and their implications are explored. The conclusion: over-all effectiveness may be optimized with some assurance of "better" solutions than would be obtained otherwise.

Economic Analysis of Major Mining Decisions by *Gershon Cooper*—The paper first considers the problems involved in analyzing a prospective major reserve acquisition by a mining company. A common set of procedures utilized in the mining industry for evaluation of reserves are presented and their deficiencies discussed. An alternative analysis is presented in terms of an actual case, and its results compared with that of the standard approach.

It goes on to consider whether the mode of analysis which seems appropriate for the reserve problem is not also appropriate for the entire class of top or upper management decision problems, including major plant or process changes, major decisions concerning equipment, etc.

SOCIETY OF ECONOMIC GEOLOGISTS

General Geology

Monday, February 19

9:30 am, Penn Top North

Ore Leads and Isotopes by *John S. Brown*—Comparison of all published analyses of commercial lead deposits, excluding Mississippi Valley ores, shows that the ratio of thorium-derived to uranium-derived lead (206 ÷ 207) has remained constant at 1.13 to 1.14 for the last 2.5 b.y. Higher figures (1.15+) denote contamination by thorium lead and lower values indicate admixture of uranium lead. Mississippi Valley ores (1.10±) are contaminated by uranium lead presumably derived from local ground water and host rock. The amount of contaminant is approximately 1.5% of total lead or 3% of the uranogenic lead.

Using this stable index one may reconstruct any simple anomalous lead and determine its original ore base. Complex contamination by both thorium and uranium lead usually can be unravelled by the aid of 206/204 and 208/204 ratios appropriate to the indicated percentage of 204. This method suggests that many anomalous leads of minor veinlets in the Canadian shield are contaminated Mississippi Valley leads probably leakages from deposits once widespread in overlying Paleozoic strata now denuded. Similarly, anomalous leads of the Baltic area indicate a former extensive Mississippi Valley stage mineralization for Europe. This seems to be still preserved in the original at Laisvall, Sweden.

Ratios of 206 and 207 to each other, especially in post-Precambrian time, are too delicately balanced and too strongly influenced by minor variables to have any reliability in age determination, but the percentage of Pb 204 is still a very useful index.

An Experimental Study of Supergene Transport of Gold by *Paul L. Cloke* and *William C. Kelly*—Previous experiments and calculations (Kelly and Cloke, 1961; Krauskopf, 1951) have defined the ranges of acidity, chloride ion activity and oxidation potential within which gold should dissolve. Solutions 0.5 M in H_2SO_4 and 0.1 M in NaCl reached a high Eh when in contact with goethite or pyrolusite and were theoretically able to dissolve gold as the $AuCl_4^-$ ion.

In the present experiments the H_2SO_4-NaCl solution was allowed to percolate through a column of pulverized goethite or pyrolusite and then to flow over a weighed gold plate. The concentrations of acid (1.0 N) and NaCl (0.1 N) were chosen to correspond to the strongest likely to exist in the gossans overlying ore deposits. When the solution passed over pyrolusite, the gold plate was strongly etched and lost weight. In one week's time about 50 ml of solution flowed over the plate and dissolved 2 mg of gold. More dilute solutions, of course, would have less effect. The solution which passed over goethite, however, had no noticeable effect in one month (about 200 ml). Nevertheless, a longer experiment might be effective.

It was concluded that the rate of solution of gold is faster when pyrolusite is used instead of goethite. This corresponds to a greater theoretical solubility in the presence of pyrolusite than with goethite and to the field observation that pyrolusite is more effective than goethite in producing supergene enrichment of gold.

Prospecting for Beryllium by *W. R. Griffitts*—Prospecting for nonpegmatitic deposits of beryllium has been handicapped by the lack of truly diagnostic geologic features and by the inconspicuousness of most beryllium-bearing minerals. The use of analyses of rock samples taken during reconnaissance examinations of promising districts is rather costly and is likely to miss the beryllium deposits because even in districts that are known to contain important beryllium deposits the percentage of the total outcrop area that contains beryllium minerals is small. In the Iron Mountain area, New Mexico, for example, only 2 to 3% of the tactite was mapped as mineralized, and probably less than half of this tactite contains beryllium. In the Lake George area, Colorado, the percent of outcrops that contain beryllium is even smaller. The nuclear devices that have been available during the last few years permit the economic checking of many more exposures than was possible with chemical analyses. Nevertheless their use has not appreciably reduced the field time needed to evaluate a district.

Evaluation of a district by the use of some characteristic of a readily sampled material is one general objective of geochemical prospecting. The beryllium content of alluvium from short streams or washes can be used to determine the presence of beryllium-rich rocks in the drainage basins upstream from the sampled localities, regardless of the nature of the beryllium minerals present. Examples are given of beryllium contents of alluvium and soils in several

(Session continued on page 1258)

beryllium district, in which beryllium determinations were made either spectrographically or by a new field chemical procedure.

Mineralogy and Paragenesis of the Telluride Ores of Boulder County, Colo. by *Wm. C. Kelly* and *E. N. Goddard*—The gold telluride ores of the Jamestown, Gold Hill and Magnolia mining districts have been investigated by microscopic and X-ray methods. A variety of opaque minerals including altaite, calaverite, coloradoite, empressite, gold, hessite, krennerite, melonite, petzite, rickardite, sylvanite, tellurium and tetradymite have been recognized in a suite of 195 polished sections. In all of the ores an intimate intergrowth of two or more tellurides is characteristic. The textures suggest the growth of some tellurides in silica gel which subsequently crystallized to form horn quartz.

Experimental work in the system Au-Ag-Te by Markham (1961) provides a basis for evaluating the degree of equilibrium maintained during ore deposition. Individual veins or groups of veins behaved as separate open systems in which the number of tellurides deposited commonly exceeded the number permitted by the Phase Rule. At any point in these veins, however, equilibrium was approached to the extent that only compatible phases are found in contact. These compatible phases commonly vein and replace one another and, where the textural evidence is clear, there is a definite telluride sequence involving an enrichment in silver and depletion of tellurium.

Gold is residually enriched by supergene processes, but there is not extensive transport of that metal. Rickardite (Cu_3Te) occurs exclusively as a supergene mineral, and, in one unusual occurrence, petzite was observed as a supergene alteration product of native tellurium. In general, the hypogene relationships are not obscured, as at Kalgoorlie, by the occurrence of some tellurides as both hypogene and supergene minerals.

Field Determination of Beryllium contents of Solids and Rocks by *Lorraine E. Patton*—In the search for beryllium minerals, detection of small to moderate amounts of beryllium in solids and rocks has become increasingly important. Rapid and sensitive determinations can be made by fusion of the sample with ammonium bifluoride, extraction of the beryllium with morin to form a fluorescent complex. Chelating agents and an alkaline buffer are added to minimize interferences.

The ammonium bifluoride fusion is effective on minerals that contain only minor amounts of Be as well as on beryllium minerals. The method is useful in the range from 1 to 100 ppm of beryllium in the sample, but with proper adjustment of the sample size or volumes of solution taken for analysis, the range can be extended. As many as 60 samples can be analyzed per day.

Monday, February 19

2:30 pm, Penn Top South

Sedimentary Facies in Relation to the Clinton Iron Ores of the Eastern U.S. by *Byrd L. Berman*—Analysis of the Silurian stratigraphy of the eastern U.S. shows that iron concentration is present throughout the Appalachian Basin east of the Nashville-Cincinnati structural lineament, an area some 200 miles in width and 950 miles in length. Ore zones cut across sedimentary facies, indicating 1) time equivalence of such zones and 2) independence of concentration process (but not amount of concentration) to any given sedimentary facies. Development of iron concentration is largely a result of diastemic conditions; development of economic deposits is a function of the character (in large part, that of grain size) of the bottom sediments during such periods. Ore development is most pronounced in those sections containing the greatest thickness of coarse clastics, either quartz sand or bioclastics. These concepts allow the preparation of lithofacies maps outlining those areas in which commercial quantities of ore can be expected. This is illustrated by such a map drawn for the Red Mountain Formation of Alabama.

Origin of Certain Magnetite-Bearing Bodies in the Eastern Part of the Bushveld Complex by *Eugene N. Cameron*—Bodies of pegmatitic rock consisting of clinopyroxene, plagioclase, emphibole and magnetite, with other minerals as yet unidentified, occur at a number of places in the Critical Zone of the Bushveld Complex in the eastern Transvaal. The bodies occupy areas ranging from a few hundred sq ft to nearly a sq mile. They are of particular interest because they carry vanadium-bearing magnetite and because they may be related to the well known platinum-bearing pipes of this area.

Studies of such bodies on Farms Annex Grootboom, Grootboom, and Tweefontein indicate that they are developed largely in the anorthosite series forming the upper part of the Critical Zone. The anorthosite series is largely a pseudostratified succession of anorthosites and nortic anorthosites, but persistent layers of pyroxemite and chromitite occur at several horizons. The chromitite seams can be traced through the pegmatitic bodies; locally the chromitites have been partially replaced by magnetite. The pyroxonite layers can likewise be traced through the pegmatitic bodies, although locally pyromenite is likewise partly replaced. It is evident that the pegmatitic bodies are not intrusive but have formed by replacement, largely at the expense of anorthositic rocks. The development of the bodies has been accomplished without disruption of the gross layered structure of the rocks of the Critical Zone.

Iron Deposits of the Quartz Lake Area, Mt. Wright Region, Quebec by *Jack V. Everett* and *Henry Lepp*—The essentially unmetamorphosed iron formations of the Labrador geosyncline cross the boundary of the Grenville metamorphic province approximately 15 miles north of Wabush Lake, Lab. and extend within this geologic province for about 200 miles southwesterly to Matonipi Lake, Quebec. In the Grenville area the iron formations are highly metamorphosed, folded and discontinuous. The purpose of this paper is to describe two iron deposits which are currently being explored near the northeast end of the belt at Quartz Lake, Que.

The principal rock types in the area are granite gneiss, biotite and garnet schists, amphibolites, quartzite and iron formation (including quartz-magnetite-specularite, quartz-specularite, quartz-magnetite-silicate and quartz-silicate varieties).

Interpretation of the sequence of formations and the geologic structures is complicated by the high degree of recrystallization, by the locally intensive plastic deformation and by the fact that there is considerable interfingering of the iron formation members, and the amphibolites. The major structures in the area appear to be doubly plunging synclines.

The favorable oxide members of the iron formation contain about 30% soluble iron. Concentration tests show that this material can be concentrated to a product containing approximately 66% iron and 5% silica, with a 40% weight recovery.

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See page 1267 for story

PICTURE STORIES OF:

LAST CALL FOR 1961 PREPRINTS

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SME-CIM INDUSTRIAL MINERALS MEN FIND MUTUAL INTERESTS AT OTTAWA

J. B. Mawdsley, President, CIM, presided at the Monday night dinner. Guest speaker Nik Cavell, former Administrator of the Colombo plan for Canada and former Canadian High Commissioner to Ceylon, gave the address: "Toward a Better World."

Left to right: G. F. Pettinos, Jr., Northeast Vice Chairman IndMD of SME; R. S. McClellan, Executive Committee, IndMD of SME; and C. Gerow, Secretary, Canadian Institute of Mining and Metallurgy, exchange ideas during hospitality hour.

From left to right: Harold M. Bannerman, former Chairman IndMD; A. B. Cummins, Past-President, SME; and G. F. Jenkins, Thetford Mines, Quebec, greet each other.

An exchange of information and warm camaraderie were the ingredients of the recent joint meeting between the Industrial Minerals Division of SME and CIM. Two hundred IndMD men and their wives from both sides of the border met at the Chateau Laurier, Ottawa, October 1 to 3. There was a day and a half of technical sessions in which a variety of subjects was discussed including refractories, fillers, the asbestos industry, ground water and exploration and beneficiation techniques.

Preparations for the field trips following the sessions were elaborate and extremely flexible in that companies were prepared to receive guests at the convenience of the travellers. The asbestos region was a big attraction, of course, but the numerous operations fairly close to Ottawa also drew a great deal of attention. The two luncheons and dinner meeting were preceded by social hours sponsored by the companies, and these sessions gave everyone an excellent opportunity to mingle and broaden their acquaintances.

The accompanying photographs show some of the notables who were in attendance.

H. M. Woodrooffe, Chairman of the Joint Meeting Committee and his associates, many of whom are from the Mines Branch of the Canadian Government, performed outstandingly in making the arrangements for the meeting. Mrs. M. F. Goudge, as chairman was responsible for the ladies program, which, among other entertaining and interesting functions, included tea at the home of the U.S. Ambassador to Canada.

Left to right: Marc Boyer, Deputy Minister of Mines; M. F. Goudge, Honorary Chairman, Joint Meeting Committee; W. T. Bray, Technical Program Chairman, CIM; J. E. Reeves, Meeting Publicity, CIM; C. F. Clausen, Chairman IndMD of SME.

During a rare pause in the round of events at Chateau Laurier, Mrs. Gillson with her husband AIME Past-President Joseph L. Gillson discuss the value of joint SME-CIM meetings with H. M. Woodrooffe, Chairman, Joint Meeting Committee, and his wife.

COAL MEN ATTEND FUELS CONFERENCE

Members of the Coal Division of the Society of Mining Engineers of AIME and of the Fuels Division, American Society of Mechanical Engineers met at the Dinkler-Tutwiler Hotel in Birmingham, Ala., October 5, 6 and 7 for the 24th Annual Joint Solid Fuels Conference. More than 195 men registered and about 45 ladies—setting a new record for this meeting.

There were four technical sessions comprised of 11 papers on the preparation and utilization of coal. Abstracts of the papers were published in the September issue of MINING ENGINEERING. The social functions got under way on Thursday at noon with the Informal Luncheon. Conference chairman James A. Hagy presided.

The banquet Thursday evening was preceded by a Social Hour. Milton Fies, AIME Legion of Honor Member, served as toastmaster for the banquet at which Joseph E. Moody, President of the National Coal Policy Conference, was principal speaker.

At the luncheon on Friday F. S. Kohl presided. He was co-chairman of the Conference for ASME. "Dick" Groenendyke officiated as toastmaster, presenting the guest speaker, General R. M. Hurst, U.S. Army, Army Ballistic Missile Agency, Redstone Arsenal. Mrs. McFarland and Mrs. Kirkwood of WAAIME and organizers of the Ladies Activities were introduced and commended for the fine job they did.

On Saturday there was a visit to the Wilsonville Steam plant of the Southern Electric Generating Co. A box luncheon was provided for those who took the trip.

The Conference immediately followed a meeting sponsored by the Southern Research Institute on the theme *Coal's New Horizons.* The consensus was that the use of coal is on the verge of a new era of expansion.

Officers shown at the meeting from left to right: J. A. Hagy, General Chairman, Solid Fuels Conference; R. R. McNaughton, AIME President; Bob Williams, Chairman, Birmingham Chapter, ASME; J. W. Nicol, Chairman, Southeast Section AIME.

J. E. Moody, who was principal speaker, chats with J. C. Gray, right, President of SME at the banquet Thursday night.

Pictured seated with Otto de Lorenzi is Mrs. McNaughton and standing behind, J. C. Tobey left and R. R. McNaughton.

Enjoying the pre-banquet social are: W. R. Kirkwood, Mrs. George McCormick, Mrs. W. R. Kirkwood, J. W. Nicol and wife, Mrs. P. J. Zukow, Mike Marchich and wife

Joseph E. Moody, President, National Coal Policy Conference, addresses the 24th Annual Joint Solids Fuels Conference.

Membership Mailing Solicits Information

Each member of SME recently received a Midyear Report from President J. C. Gray.

Attached to this was a list of all SME members in your local section. This list was produced on our IBM from data punched into cards. Limitations of the machine and the code used were explained in a cover page. The machine cannot make a mistake but the humans who operate the card punching machine can—and they did in some cases. Considering the opportunities for error, they made very few. However, we want to render to you the best service possible. This we cannot do if we are operating with incorrect data.

Will each of you, therefore, please read carefully the explanation of the coding; then take into account the limitations of the machine that shortened some names by a letter or two; find your own name on the list and determine whether you have been coded correctly.

If there is aught amiss let us know immediately so we can take steps to correct your card.

The AIME Board has authorized a survey of the entire membership to determine each member's correct interests. Every punched card will be brought up to date and the information included as code letters in the alphabetical portion of our next directory.

Please, in the interest of better service to you, respond as soon as possible to the request for information on your interests when it comes.

In the meantime please check the list of SME members attached to President Gray's report and let us know immediately if there is any inaccuracy in *your* listing.

British Iron, Steel Men Hold Meeting in U.S.

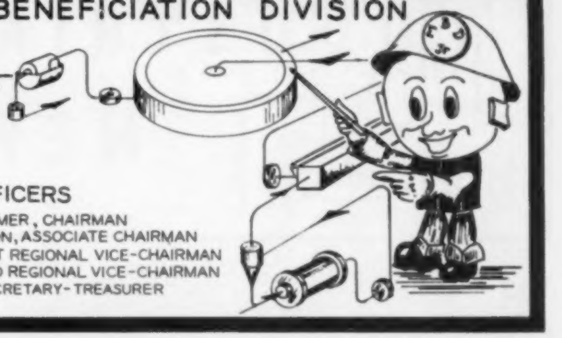
Members of The Iron and Steel Institute (of London) held their first meeting program in the U.S. in half a century through the cooperative efforts of the Metallurgical Society of AIME. The inaugural session was held at the new United Engineering Center on October 19 and featured a lecture by James B. Austin, vice president, research and technology, U.S. Steel Corp., entitled *Three Centuries of Progress in the American Iron and Steel Industry.*

An extensive tour of many of the major U.S. and Canadian iron and steel plants had been arranged. Alternate tours were planned—tailored to the individual interests of the men. Their stay extends from October 17 to November 8.

They also had an opportunity to attend the American Society for Metals' National Metal Congress and Exposition in Detroit and The Metallurgical Society's Fall Meeting held in conjunction with the Congress.

MINERALS BENEFICIATION DIVISION

DIGEST



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Division Plans for 1962 Annual Meeting

Our Associate Chairman, Steve Erickson, and his Technical Committee Chairmen have assembled an excellent program for the New York meeting.

A preview is outlined below—the final lineup may be augmented or rearranged. The papers and authors shown are assured as of this writing.

Basic Science

The Concept and Measurement of Negative Interfacial Tensions at Liquid/Liquid Interfaces by *J. H. Schulman*, Columbia University.

Defect Concentrations in Alkali-Silicate Glasses by *R. J. Charles*, General Electric Co.

Chemical Process—Joint MBD-EMD

Pilot-Plant Development of a Sulphation Process for Complex Sulphide Ores by *R. E. Lund*, St. Joseph Lead Co.

Removal of Vanadium from Impure U308 Concentrate by *C. N. Garman*, Homestake-New Mexico Partners.

The Leaching Characteristics of Uranium from Some South Dakota Lignites by *S. C. Sun* and *J. W. Fetterman**, Pennsylvania State University.

Oxidation of Galena in Aqueous Solutions Under Pressure by *A. Vizsoly, H. Veltman* and *F. A. Forward**, University of British Columbia.

The Physical Factors Governing the Leaching of Ores by *N. M. Levine*, Stein, Hall & Co.

Metallic Ion Absorption by *E. A. Sigworth*, W. Va. Pulp & Paper.

Operating Controls

Automatic Controls in Flotation by *Dexter Hatch*, National Lead Co.

Automatic Control of Filter Feed by *G. H. Sheary III*, Bethlehem-Cornwall Corp.

Use of Computers in Mineral Beneficiation by *W. W. Leutert*, Remington Rand Corp.

Elements of Dishonest Data Presentation by *James E. Lawver*, International Minerals & Chemical Corp.

Neutron and Gamma Instrumentation for Continuous Measurement of Moisture and Density by *O. K. Neville*, Nuclear Chicago Corp.

Mill Design

The Atlantic City Story by *Cohlmeyer, Henderson* and *Morgan*, U.S. Steel Corp. To be presented by *R. C. Talbott**.

Tunnel Reclaim Systems for Bulk Products by *Leo Borasio** and *S. A. Romlov*, Stearns-Roger Mfg. Co.

Blending of Cement Raw Materials by *George Carter*.

Maintenance Problems at Mines Development Inc. by *E. W. Davis*.

Concentration

Kinetics of Flotation by *C. H. G. Bushell*, The Consolidated Mining & Smelting Co. of Canada Ltd.

Liberia Mining Co. Ltd., Operation Iron Ore Beneficiation Plant by *D. F. Boyd*, Stearns-Roger Mfg. Co.

Converting Gravity-Flotation Plant to All Flotation by *H. A. Hoffman*, St. Joseph Lead Co.

Dry Autogenous Grinding and Dry Magnetic Concentration of Iron Ores by *F. Everard*, Ontario Research Foundation.

A flotation paper by *T. P. Meloy*, MIT.

** Flotation of Chrysocolla by *Tom Chen*, N. M. Institute of Mining & Technology.

**Not confirmed

Concentration—Joint MBD-IndMD

Selective Froth Flotation by *E. W. Greene** and *J. B. Duke*, Minerals & Chemicals Philipp Corp.

Flotation paper by *P. L. de Bruyn*, MIT and *F F. Aplan**, Union Carbide Nuclear Co.

Barite Mineral Dressing by *Earl L. H. Sackett*.

Beneficiation of Kyanite Ores by *J. E. Castle*.

Fluorspar Beneficiation by *G. H. Musson*.

Clay—Silica Sand Separation at Owens-Illinois Glass Co. by *J. C. Hamilton, Sr.*

Pyrolysis and Agglomeration

Treatise on Design Evolution of Verticle Shaft Furnaces by *A. W. Storm*, Midland-Ross Corp.

Stationary, Cross-Blown Sinter Cooler by *E. P. Howald**, Jones & Laughlin Steel Corp. and *F. W. Kinsey*, Graham Research Laboratory.

Operating and Start-up of the Humboldt Pellet Plant by *D. M. Urich*, Cleveland-Cliffs Iron Co.

Reduction Roasting and Concentration of Mesabi Range Semi-Taconite by *Fred H. Bunge**, The Hanna Mining Co. and *W. T. Rule*, The M. A. Hanna Co.

Crushing and Grinding

Particle Size Measurement and Control by *U. N. Bhrany*, U.S. Steel Corp.

Effect of Grain Size on Size Distribution by *F. C. Bond*, Allis-Chalmers Mfg. Corp.

Particle Size Analysis in the Portland Cement Industry by *E. S. Porter*, Portland Cement Assn.

Size Analysis and Control in Nuclear Applications by *A. Beianchert*, Numec Corp.

Autogenous Grinding by *B. Bernstrom*, Jones & Laughlin Steel Corp.

Size Control in Southwest Copper Plants by *H. K. Burke* and *Russell Salter*.

Solids-Fluid Separation

Sedimentation Process Fundamentals by *Bryant Fitch*, Dorr-Oliver Inc.

Breaking Emulsions with Corona Discharge by *J. L. Carswell*, Carpco-Kewanee Inc.

An Analysis of the Wash Thickener Two Stage Filtration Circuit by *R. S. Olson*, The Dow Chemical Co.

Clarified Solutions by Reversible Cake Filtration by *J. G. Brown*, Granger Filter Co.

Slime Removal from Mill Solutions by Froth Flotation by *F. N. Oberg* and *C. N. Garman**, Homestake-New Mexico Partners.

Handling of Total Ore in a CCD Thickener Circuit by *O. J. Malacarne* and *D. G. Millenbruch**, Union Carbide & Nuclear Co.

Thickeners-New Concept in Design, Arrangements and Control by *D. L. King** and *B. A. Schepman*, The Eimco Corp.

Dewatering and Processing of Kaolin Clays by *W. M. Phillips*, The Eimco Corp.

Materials Handling and Storage

Uses of Glass Reinforced Plastics by *R. W. Burns*, The Galigher Co.

Pneumatic Conveyors—Their Application in the Minerals Industry by *H. A. Stoess, Jr.*, Fuller Co.

Accurate Mixing of Sized Materials by *E. P. Larsen*, Hewitt-Robins Inc.

Liquid Sulfur Transportation and Storage by *J. E. Monroe, Jr.** and *F. L. Jackson*, Freeport Sulphur Co.

Deep Well Construction for the Disposal of Uranium Mill Tailing Water by *R. D. Lynn* and *Z. E. Arlin**, The Anoconda Co.

A Three Dimensional Belt Conveyor by *Gord Klinkenborg*, Albet Stubbe, Vlotho, West Germany.

Note: Where more than one author is listed, * indicates who will present the paper.

SEE YOU IN NEW YORK

INDUSTRIAL MINERALS NEWSLETTER

Things to Come

Interesting topics abound in the preliminary program for the Annual Meeting at New York in February. Ray Kazmann and his corps of able assistants on the Program Policy Committee have been signally successful in lining up a fine schedule.

A joint session with the Minerals Beneficiation Division will feature beneficiation of industrial minerals. Papers tentatively scheduled include *Beneficiation of Kyanite Ores* by James E. Castle, *Barite Mineral Dressing* by Earl L. H. Sackett, *Blending of Cement Raw-Materials* by George Carter, *Clay-Silica Sand Separation at Owens-Illinois Glass Co.* by J. C. Hamilton, Sr., *Fluorspar Beneficiation* by George H. Musson, *Bentonite Exploration and Evaluation* by T. W. Smoot.

Minerals for Special Uses will be the theme of another session. Tentative papers include *New Beryllium Ore Developments* by Eugene B. Hotchkiss, *Outlook for Mica* by S. A. Montague, *The Rare Earths Picture* by Howard E. Kremers and *Trends in Graphite Use and Supply* by John J. Schanz, Jr.

The Industrial Waters group always manages to arrange some provocative topics, and this time is no exception—water being vital to nearly everything. The tentative papers so far scheduled are *Water—Vital Raw Material in the Mining and Processing of Phosphate Ore* by L. A. Roe, *Depletion Allowance for Ground Water* by F. W. Mueller, *Ground Water Studies in the Soviet Union* by V. P. Sokoloff, *Dewatering a South African Gold Mine* by M. L. Brashears.

Exploration and development of industrial minerals continues to be a hot item as evidenced by the fact that seven tentative papers are "on the fire." They are: *Use of Well Logging in Exploration for Evaporite Deposits* by Robert N. Urash and Don R. Richner, *Salt Deposits and Future Possible Discoveries in the Southeastern States* by William A. Riggs, *Michigan Limestone Industry* by Carl G. Hogberg, *Exploration for Fluorspar* by Ervin A. Brecke, *The Cutting of Dimension Stone—New Developments* by Howard L. Hartman, and a paper on light-weight aggregates, the exact title and author of which was still unclear at deadline time.

See pp. 1251-1252 for a substantial portion of abstracts. The remainder will be published in the January issue of MINING ENGINEERING.

Better make that hotel and transportation reservation now! It will be an interesting and well worthwhile annual meeting.

Gleanings at the AMC Seattle Convention

The importance of industrial minerals to the State of Washington is shown in the recently released *Directory of Washington Mining Operations 1960* (Information Circular No. 35) published by the Washington State Division of Mines and Geology. The metallic index fills 1⅛ pages. The industrial minerals index fills 2⅞ pages. Twenty-three different minerals are commercially produced in the state in addition to four varieties of stone. The list of operators, tabulated by industrial mineral commodities, showed 157 operations in commercial production.

Marshall T. Huntting, supervisor of Washington's Division of Mines and Geology, further demonstrated the significance and distribution of minerals in his state by arranging to have on display a giant illuminated relief map showing occurrence as well as production. An automatic lighting circuit showed for each mineral or metal successively sites of operations as well as undeveloped occurrences. Different colored bulbs showed the state of development.

Richard (Pete) Foose, active in AIME circles, presented an interesting and informative paper entitled *The State of the Industrial Mineral Mining Industry*. Copies of it may be had by writing to him at Stanford Research Institute, Menlo Park, Calif. The most recent year (1959) for which complete figures were available showed national production of industrial minerals to be worth $3.7 billion. Mr. Foose declared that the ratio of value of industrial minerals to metals is three to one. The situation relating to zoning problems was succinctly discussed. It is a "problem that metal mines rarely meet, Foose said "but undoubtedly it . . . will become increasingly common for the producers of industrial minerals."

Record sales of construction minerals were forecast by Foose for 1961 because of the expected $57.8 billion of building. The sales, however, continue to present a cost-price squeeze problem caused by inflation, and rising costs for equipment, freight rates and labor. Increased automation and upgrading of products are two weapons reasonably successful in combating the problem. A third is consolidation of smaller companies with large industrial complexes.

Fertilizers (mineral), a major component of the chemical raw material business, are expected to pass the eight million ton per year level in 1961, Dr. Foose maintained. A significant new feature is the anticipated mining of a good grade of phosphorite on the continental shelf off southern California. The mineral is under 600 ft of water! The State of California has granted a mining permit for this project.

Industrial minerals were mentioned and discussed by many at the convention of the Mining Congress. There seems to be an increasing realization of the importance of industrial minerals to the national economy, security and welfare. Technical papers presented involving industrial minerals included *Open Pit Mining of Rock Salt* by Adolph V. Mitterer, *New Phosphate Operation Near Vernal, Utah* by R. K. Barcus, *The Importance of Research in Creating Mineral Resources* by Thomas B. Nolan, *Ground Water Control at Grace Mine* by G. K. Biemesderfer and R. H. Leske, *New Source of Silica for the Pacific Northwest* by Hugh H. Bein, *Recent Developments in Open Pit Haulage* by E. R. Borchert, *Cement Manufacturing Processes—European vs. American* by Erik Voldbaek, *Texas Gulf Sulphur Co.'s New Potash Project* by C. F. Fogarty and Frank Tippie, *Grouting for Control of Ground Water* by Lionel A. York, *Transportation of Solid Materials by Pipeline* by Edmund E. Chapus and Elie Condolios.

Gleanings from the Press

Susquehanna Corp. is exploring a deposit near Sante Fe, N.M., in which initial results are reported to indicate substantial quantities of germanium as well as some copper and uranium (Gold News, San Andreas, Calif.)

Minerva Oil Co. has a drilling project on the Miller helvite property in the Mineral Range, Beaver County, Utah. Helvite was found in the first drill hole completed.

Beryllium Resources, Inc. (an Odlum firm), announced the successful

concentration of domestic beryllium ores "by chemical flotation." A concentration plant is to be built by the company near Delta, Utah. (Ely, Nev. Times)

Union Carbide Nuclear Co. is reported to be exploring a deposit believed to contain rare earth minerals north of Bowie, Ariz. (Arizona Republic)

The newspaper, *Arizona Republic*, reports that more major mining companies are "looking for ore" in Arizona than at any time in many years. Also, many new companies have established exploration offices in the state and are looking for mines.

Near-drought conditions in the Santa Barbara, Calif., area resulted in rapid shrinking of water reserves in Lake Cachuma this year. Reduction of evaporation losses is being attempted by laying a thin chemical blanket (hexadecanol) on the lake surface. The Bureau of Reclamation estimated that annual evaporation loss from the lake is 12,500 acre ft (about 4 million gal) of water. The hexadecanol is expected to reduce the loss appreciably. [It lies on the surface as a monomolecular film according to other reports.] The hexadecanol [an alcohol] is said to have no deleterious effects on fish or the purity of the water. (New York Times)

Zoning

The troubles of mineral operators with zoning and urbanization are emphasized again by the following two reports gleaned from California papers. If the mineral industry is to exist near urban developments, a lot of educational work needs doing. The average citizen has little or no idea of what a plentiful low-cost supply of "common" minerals means to his own welfare and pocketbook.

Each member of the City Council, and the City Clerk of Carlsbad, San Diego County, Calif., were served with Writs of Mandamus for their issuance of a conditional use permit to the South Coast Asphalt Products Inc. to operate a rock quarry on Vista Way. Among the charges made by the petitioners are claims that they were denied a fair and impartial hearing, and that the Mayor was not qualified to act on the issue because he is a resident of Orange County and not legally qualified to sit as a member of the City Council of Carlsbad. (Carlsbad Journal)

Plans for close cooperation with Irwindale, Calif., citizens in defeating an Irwindale ordinance granting zoning for a quarry adjacent to Duarte, Calif., were outlined at a meeting of the Home Owners Protective Assn. of Durate Youth Acres. Irwindale residents were pushing a referendum move in an attempt to reverse their City Council's three-to-one approval of the quarry zoning. (Pasadena Independent)—*Leon W. Dupuy.*

Prepublication Prices Expire DECEMBER 1 for 50th Anniversary

FROTH FLOTATION VOLUME

Now is the time to send in your check to take advantage of the prepublication price for the 50th Anniversary Froth Flotation Volume. This special low prepublication price of $8.00 to members and $12.00 to nonmembers applies only to orders postmarked before December 1, 1961. This completely original work has been several years in the planning and the chapter subjects and authors have been selected, respectively, for their usefulness and competence, by the best men in the business; that is the members of the Minerals Beneficiation Division of the Society of Mining Engineers. Look over the partial contents list below.

Early American Ore Dressing Practice—*P. R. Hines*

Sketch of Early Commercial Flotation—*P. R. Hines and J. D. Vincent*

Historical Outline of Major Developments in Flotation—*E. H. Crabtree and J. D. Vincent*

The Magnitude and Significance of Flotation in the Mineral Industry of the U. S.—*C. W. Merrill*

Physical Chemistry of Flotation Systems—*P. L. de Bruyn*

Theory of Nonmetallic Mineral Flotation—*F. F. Aplan and D. W. Fuerstenau*

Theory of Sulfide Mineral Flotation—*J. Rogers*

Froths and Frothing Agents—*R. B. Booth and W. L. Freyberger*

Flotation Kinetics—*N. Arbiter and C. C. Harris*

Applied Flotation Research and Development—*R. J. Brison and R. D. Macdonald*

ROCK IN THE BOX

Mining & Exploration Division

Gloyd Marlin Wiles, manager of mines for National Lead Co., has been named recipient of the Jackling Award and Jackling lecturer for 1962. In making the announcement the committee gave this citation: "For his ability to organize mines, to inspire young men with the spirit of success and a firm belief in careful planning, imaginative research and competent engineering and for his lecture *Mine Management.*" Frank R. Milliken, president of Kennecott Copper Corp., will make the presentation. The two men had been associates when Mr. Milliken was with National Lead Co. during the 1940's.

Mr. Wiles was born in Hanford, Calif. in 1898 and received his B.S. degree in mining engineering from the University of California in 1923. He began his career with Granby Consolidated in Anyox, B.C. In 1924 he joined Bunker Hill Co., and the following year was sent to Sudbury, Ont. as general superintendent of its subsidiary, Treadwell Yukon Co. Ltd.

He went to work for John Hays Hammond in 1934, becoming successively field engineer, general manager, director and vice president of Park City Consolidated Mines. While there he was responsible for commercial development of high (2200) voltage submersible motors directly connected to deep well turbines and for the publication of this development.

In 1942 he joined National Lead Co., where he was responsible for the operation of its Tri-State, Kan.; Fredericktown, Mo.; and MacIntyre, N. Y. mines before being appointed to his present position in January 1948. In the course of these later years Mr. Wiles has had to take to the field for the start-up and organization of Nicaro Nickel Co. in Cuba and Titanum Alloy Mfg. Proprietary Ltd. in Australia.

These are the basic facts which neither describe the man who holds the high regard of his contemporaries that prompted his selection as recipient of the Jackling Award, nor do they do justice to the career of the man whose personality and enthusiasm has had such a profound effect upon his associates.

To fill in some of the gaps in the foregoing, Gloyd Wiles enrolled as a "pre-med" student at the University of California in 1916. His

GLOYD M. WILES

career in medicine was interrupted by World War I, and during the interruption he met and was greatly influenced by Frank Probert, Dean of the College of Mining at the University. This resulted in Gloyd's registering in Dean Probert's College of Mining in the spring of 1920.

One incident in his undergraduate days that had a lasting effect on him was the underground fire at the Argonaut mine at Jackson, Calif. This was probably the major metal mine disaster of the country, resulting in loss of lives by suffocation. Gloyd Wiles, trained as he was in the use of oxygen apparatus, led a mine rescue team from the University to assist in fighting the fire and in rescue operations. Although it was soon apparent that rescue operations would not be successful, he stayed on working with the emergency crews until the bodies of the unfortunate victims had been recovered.

His first job after graduation at Anyox, B.C. was primarily important in his life because it was there he met and married his wife, Virginia Irene McConkey. She had come to Anyox on a visit to a school friend, the superintendent's daughter.

In 1924 the Wiles moved to Kellogg, Idaho, where Gloyd joined the Bunker Hill and Sullivan, the operation which was the subject of his thesis. In retrospect, Kellogg has another important place in Gloyd Wiles' life, since here his daughter June was born.

When Treadwell-Yukon Ltd., primarily financed by Bunker Hill and Alaska Juneau, acquired a Pb-Zn prospect at Sudbury, Ont. in 1925, Gloyd Wiles was sent to supervise and direct an extensive diamond drilling program and subsequent underground exploration. Not all prospects make mines, and unfortunately this prospect was one that didn't; so in 1928 Gloyd Wiles went into exploration and diamond drilling with the Sudbury Diamond Drilling Co.

The Great Depression had its effect on mine exploration in the early '30's, and following an intermediate period with the Telephone Co. he became associated with the John Hays Hammond Property, Park City Consolidated, in 1934.

In 1942 he joined National Lead Co. to reorganize the Baxter Springs operation at Baxter Springs, Kan. Shortly thereafter the Madison operation at Fredericktown, Mo., was put under his direction. His work with these properties was in the pioneering stage of trackless mining and underground diesel engine techniques.

In 1944 he was transferred to the MacIntyre operation in Upstate New York where he again showed his talent for development of both the potentialities of the property and the operating personnel. In 1947 he was transferred to New York to head the Mining Department of National Lead.

In 1952, at the time Nickel Processing Co., a subsidiary of National Lead, took over the management contract for Nicaro operations in Cuba, he was sent to rehabilitate the plant and to organize both the plant operating procedures and manpower requirements.

At the time of the surge of interest in titanium metal a few years ago, he directed the development of a new type concentrating plant for the recovery of rutile from the beach sands of Australia.

No summary of Gloyd Wiles' career could be complete without mention of his outside interests. He is an ardent sportsman and is equally expert with a fishing rod, a shotgun or a rifle. In the last few years he has taken up sailing—he captains a beautifully fitted sloop.

Program Plans for the Annual Meeting

Ralph Lofquist, the Program Committee vice chairman responsible for Annual Meeting planning, reports that preliminary program arrangements are well under way and that the sessions should prove to be the best yet. The Utilization and Mining sessions are pretty well set, but the program for the Preparation session has not been completely worked out as we go to press.

The Mining Committee has planned four symposiums—an innovation which it feels will prove to be of great interest to the members—as follows:

Maintenance and Automation—chairmen: D. C. Ridenour and R. W. Storey. Papers to be presented include: *Automation Designed for Maintenance* by R. R. Godard, U.S. Steel Corp.; *Trained Manpower and Progress in the Mining Industry* by James L. Patton, Dept of Education, Commonwealth of Kentucky; *Specialized Maintenance Test Equipment* by C. L. Sarff, Hanna Coal Co.; and *Maintenance and Operating Practices for Mining Machinery from the View Point of the Manufacturer*, J. S. Newton, Goodman Mfg. Co.

Mine Safety and Ventilation—chairmen: R. Ward Stahl and J. D. Kalasky. Two papers on mining ventilation will be presented: *Ventilation of Gob Areas and Use of Bleeder Systems* by Stephen Krickovic, Eastern Gas & Fuel Associates and *Determining Ventilation Requirements with Continuous Miners* by H. L. Hartman, Pennsylvania State University. The other papers scheduled at this session are: *Fighting Mine Fires* by D. W. Mitchell and John Nagy, USBM and *Roofbolting Experiments* by Robert Stefanko.

Research in Coal Mining—chairmen: J. Richard Lucas and James E. Brown. Papers scheduled are: *Role of the Office of Coal Research* by W. A. McCurdy, Office of Coal Research; *Permeability of Coal to Gas Flow* by W. H. Huang, Carpco Research & Engineering Co. and T. C. Shelton, Jr., Virginia Polytechnic Institute; *Important Fundamental Properties of Coal* and *Evaluation of Some Elastic Rock Properties by High Frequency Wave Energy* by H. E. Rutherford, North American Coal Corp. and J. R. Lucas, Virginia Polytechnic Institute.

The final symposium is on Bituminous Coal Mining Systems with George W. McCaa and D. A. Zegeer as chairmen. Four papers on mining systems will be presented but at this writing details are not yet available.

The Coal Utilization session will consist of four papers: *Direct Operating Efficiencies for Modern Coal Heating Equipment* by R. J. Grace, Bituminous Coal Research Inc.; *A Review of Coal Processing Methods* by Harry Perry, USBM; *Continuous Manufacturing of Coke in a Rotary Hearth Furnace* by J. B. Taggart, Wise Coal & Coke Co. and Thomas Lloyd, Salem Brosius Inc. and *Automatic Sampling of Railroad Cars at Dockside Dumping Points* by Melvin W. Dadd.

Percy Nicholls Award for 1961 Announced

This year's recipient of the Percy W. Nicholls Award (established in 1942 by the Coal Division of the Society of Mining Engineers of AIME and the Fuels Division of ASME) is Otto de Lorenzi, an ASME Fellow.

Mr. de Lorenzi was born in Dallas, Texas, in 1893. He received his education at the University of Dallas and Cornell University. Most of his professional career was spent with Combustion Engineering Inc., of New York. From 1954 until his retirement he served the firm in the capacity of fuel consultant. Since his retirement he has made his home in Winter Park, Fla.

Otto de Lorenzi, left, is presented the Percy Nicholls Award by Julian C. Tobey.

The citation honoring Mr. de Lorenzi reads: "For Notable Scientific or Industrial Achievement in the Field of Solid Fuels in Recognition of the Outstanding Achievement of Otto de Lorenzi in the field of solid fuels, The Fuels Division of The American Society of Mechanical Engineers and the Coal Division of the Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers confer upon him the Percy Nicholls award for 1961.

"His patient studies led to the development of a technique for producing colored motion pictures that permitted the recording of actual furnace operating conditions with various types of fuel burning equipment using many different fuels.

"His comprehensive and authoritative reference text *Combustion Engineering*, served greatly in the dessemination of new techniques and practices in fuel burning throughout the world.

"Moreover, his manifold services to the engineering societies, his many papers and articles greatly enhanced the role of the societies and the technical press in furthering the overall knowledge of his fellow engineers."

The award was presented at the Joint Solid Fuels Conference in Birmingham. (See page 1261 for that story.)

Coke Production Seminar Held in Canada

A cooperative meeting, sponsored by a group of Canadian and U.S. steel and coal company executives, was held October 5 to 7 at Mitchel, B.C. The purpose of the meeting was to compare research and operating data on various coke production processes. Invitations were issued to iron and steel, coal and coke and chemical company executives in some 30 countries.

Highlight of the three-day meeting was a seminar discussion on Friday afternoon, October 6, led by David E. Wolfson, a leading U.S. authority on coal carbonization. The seminar covered trends in coke production technology and economics, by-product costs and revenues and coal chemical markets.

Coal Division News Editor
RAYMOND E. DAWSON

Education News

USGS Specialists Aid University of Arizona Program

The University of Arizona's graduate program in scientific hydrology (recognized as the nation's first formal educational program in the science of water) will receive initial teaching aid from three top USGS specialists. They are Nicholas Matalas of the surface water branch, Washington, D. C.; John G. Ferris of the groundwater branch, Washington, D. C.; and Herbert Skibitzke, principal mathematician for the water resources division, Phoenix, Ariz.

The University sought aid from the Survey because of the very limited number of hydrologists engaged in teaching. USGS will supply part-time teaching aid for a period of three to five years to give the program time to develop its own staff. Because of urgent need for professional hydrologists, T. A. Nolen, USGS director, and Luna Leopold, chief of water resources, have been interested in aiding the development of a curriculum leading to B.S., M.S. and Ph.D degrees in scientific hydrology.

New courses serving as the core of the University of Arizona program are: field hydrology, hydrologic systems, dynamics of flow systems of the earth, continental hydrology, analog model analysis of hydrologic systems and mathematical statistics in hydrology. The program is under the direction of John W. Harshbarger, head of the geology department.

Cornell University Offers New Graduate Program

A new graduate program in engineering geology and groundwater has been established at Cornell University under the guidance of George A. Kiersch. Centered in the geology department, the geological courses are combined with those of allied departments in the College of Arts and Sciences and integrated with supporting courses offered as a minor in one of three other Colleges—Engineering, Agriculture or Architecture. The first students under the program are enrolled this fall at both the M.S. and Ph.D. levels. Several research projects in the fields of engineering geology and groundwater have been initiated on the basis of grants-in-aid already received. One of these projects deals with *The Global Geothermal Steam Resources* and another with the *Engineering Significance of Recent Sedimentation in Great South Bay, Long Island, New York.*

EJC Official Consults on Student Exchange

Josef Wischeidt, Jr. secretary of the Committee on International Relations of Engineers Joint Council, recently paid a visit to Paris to meet with officials of UNESCO to discuss Engineers Joint Council's cooperation with that organization. He was also a guest of the German National Committee of the International Assn. for the Exchange of Students for Technical Experience (IAESTE) on a tour of German industries in which American students are currently training. The purpose for Mr. Wischeidt's visit, in his capacity as executive secretary of the U.S. Committee of IAESTE, was to determine the reasons for the extensive participation of German industry in this student exchange program with a view toward increasing U. S. participation. He also conferred with French and Austrian representatives of IAESTE.

ECPD Annual Meeting Session on Engineering Education

A highlight of the 29th Annual Meeting of Engineer's Council for Professional Development held October 2 and 3 at Louisville, was the Engineering Education Session held Tuesday morning. The topic for discussion was: Where does professional specialization belong in the engineering curricula? Ralph A. Morgen, president of Rose Polytechnic Institute, was chairman of the session.

Speakers included LeVan Griffis, Dean of the College of Engineering, Rice University who spoke from the standpoint of the undergraduate curriculum; Linton E. Grinter, Dean of the Graduate School and director of research, University of Florida who spoke for the graduate curriculum; William K. Selden, executive secretary, National Commission on Accrediting who spoke on the effect on accreditation principles and procedures; and Lloyd E. Elkins, President-Elect of AIME, who spoke on the subject in relation to industry needs.

Scholarships

National Science Foundation Awards Research Grant

Michael Klugman, assistant professor of geology at the Colorado School of Mines, has been awarded a $27,000 National Science Foundation grant for ore deposits trace elements research. By correlating trace elements—non-ore elements which form a halo around deposits —Dr. Klugman hopes to determine specific patterns for particular ores. If the project succeeds it may lead to the creation of a new exploration tool for locating new ore deposits. His project, which combines field and laboratory work, will utilize Colorado School of Mines graduate students as assistants. Dr. Klugman began environmental ore deposit research eight years ago, and he has received financial assistance from The Colorado School of Mines Foundation Inc. over the past three years.

Six Students Receive Louis Ware Scholarships

Six students at leading mining colleges have been named winners of the 1961-1962 Louis Ware senior-year scholarships of $1000 each. They are: Thomas Tisone, Colorado School of Mines; John N. Johnson, Michigan College of Mining and Technology; William Hustrulid, University of Minnesota; David Delling, Missouri School of Mines; S. David Irons, Pennsylvania State University; and Thomas Mika, Stanford University. This is the second year of the award program sponsored by International Minerals & Chemical Corp. (Details for the program appeared in the April 1961 issue of MINING ENGINEERING, page 410.)

Around the Sections

• The **Midwestern Coal Subsection** (St. Louis and Chicago Sections) held its monthly dinner meeting September 21 at the Benton Country Club. Harry Williamson was speaker of the evening—his subject *Horizon Mining*. Mr. Williamson has spent most of his time between 1952 and 1955 in Zongaldak, Turkey as an engineer and mine manager for Hamilton Overseas Construction Co. This experience formed the basis for a very interesting and instructive program.

• A field trip and inspection visit of the sintering plant and Blast Furnace Div. of Granite City Steel Co., Granite City, Ill. provided a change of pace for members of the **St. Louis Section** at their October 13 meeting.

• Close to 50 people attended the meeting of the **El Paso Section** held September 13 at the Hotel Cortez. Major Robert J. McBrinn, Chief of Information, U.S. Army Air Defense Center, Ft. Bliss, Texas, was guest speaker. He presented an illustrated talk entitled *Air Defense Center and Air Defense*.

The International Mining Days banquet held October 16 took the place of the Section's monthly meeting. AIME President R. R. McNaughton spoke at the Welcoming Luncheon the following day.

• The **Pittsburgh Section** held its Annual Smoker on October 6 at the Penn-Sheraton Hotel. The evening was devoted to conviviality.

• Highlighting the September 30 meeting of the **Adirondack Section** was a tour of the Vermont Marble Co. Covered Quarry at West Rutland, Vt. Interesting features of the tour were the special methods used to extract the marble and the high marble pillars in the quarry. Following the tour a symposium on *Some Modern Aspects of the Safety Program* was held at the 19th Hole Restaurant.

• A record attendance of more than 160 persons heard a discussion of *Direct Reduction of Iron Ore Without the Use of Blast Furnace* at the September 7 meeting of the **Southeast Section.** This meeting was the first of the fall series designed to attract the metallurgical engineers to the newly formed metallurgical subsection. Development of this unusual process was sponsored by McWane Cast Iron Pipe Co. A well-organized presentation of the process was given by a panel consisting of B. W. Worthington, retired director of research at McWane, and Thomas B. Ban and C. B. Thompson of McDowell Inc., Cleveland. At the end of the formal program a spirited question and answer session was conducted by the panelists.

• A visit by AIME President R. R. McNaughton and his wife highlighted the Annual Meeting of the **Nevada Section** held in conjunction with the **Eastern Nevada Subsection,** at Ely on September 16. C. J. Hicks, AIME Western Field Secretary was also on hand. Inspection trips to the nearby mining, milling and smelting facilities of the Nevada Mines Div. of Kennecott Copper Corp. supervised by C. E. Harris, public relations director for the company, provided pleasant morning and afternoon outings in the clear, brisk air of eastern Nevada.

The Woman's Auxiliary, chaired by Mrs. L. B. Mathis, entertained Mrs. McNaughton at a noon bridge luncheon while President McNaughton and the members of the Nevada Section were briefed on the geology of the Robinson Mining District by H. L. Bauer, Kennecott's Nevada Mines Div. geologist, at a stag lunch.

Following an enjoyable social hour in Ely's Hotel Nevada, the Annual Meeting Banquet, with John C. Kinnear, Jr., general manager of Kennecott's Nevada Mines Div. and Past-President of The Metallurgical Society of AIME acting as toastmaster, completed the day's activities. The evening's agenda included an expression of thanks to R. D. Larsen for arranging the program; a brief business meeting conducted by E. F. Lawrence, chairman of the Nevada Section; and a report on the Las Vegas Industrial Minerals Conference by its general chairman, Victor Howard. The principal speakers were John G. Smith whose topic was *Sidelights of a Chilean Contract* and President McNaughton who spoke on the history of Cominco's operations at Trail, B. C.

R. D. Larsen, secretary-treasurer of the Eastern Nevada Subsection, greets the R. R. McNaughton's at the Ely airport.

From left: James Nicol, chairman of the Southeast Section talks to panelists B. W. Worthington, C. B. Thompson and T. B. Ban as M. B. Lanier, the moderator, looks on.

M. J. O'Shaughnessay, Kennecott Copper Corp., describes Liberty Pit operations to R. R. McNaughton and E. F. Lawrence.

SME PREPRINTS AVAILABLE — 1961 Annual Meeting, St. Louis

The following list of papers (from the 1961 St. Louis Annual Meeting) will be available until January 1962. Coupons (blue) received with the 1961 Dues Bills and those distributed at the Annual Meeting will be honored until Dec. 31, 1961. Purchased coupon books (yellow) will be honored at any time. As more preprints become available they will be added to this list and bulleted (•).

Preprints may be obtained (upon presentation of properly filled out coupons) **from Preprints, SME Headquarters, 345 E. 47 St., New York 17, N. Y.** Additional coupon books can be obtained from SME for $5 (book of ten) to members or $10 (book of ten) to nonmembers. Each coupon entitles purchaser to one paper. **Please do not use coupons for papers other than those listed by number.**

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COAL (F)

Bowman, E. V., and Hurst, E. J.: *Material Handling Aspects of Fine Coal Cleaning,* **61F68.**

Boyle, J. A., and Conn, O. S.: *Control of Mine Ventilation Utilizing Multiple Main Fans,* **61F49.**

Elliott, M. A.: *Coal Gasification for Production of Synthesis and Pipeline Gas.* **61F61.**

Hamilton, G. M.: *Gasification of Solid Fuels in the Wellmann-Galusha Gas Producer,* **61F8.**

Hightower, T. R., and Mellor, M. W.: *Thunderbird Collieries,* **61F64.**

Jamison, R. H., Jr.: *Full Dimension Systems,* **61F36.**

MacDonald, J. W.: *Coal Preparation Plant Facilities, Old Ben Mine No. 21, Sesser, Franklin County, Illinois,* **61F69.**

Macpherson, H.: *Froth Flotation in Durham Division of National Coal Board,* **61F42.**

Miller, J. W.: *Economic Justification for Froth Flotation,* **61F66.**

Mongan, C. E., Jr., and Miller, T. C.: *Use of Sonic Techniques in Exploring Coal-Mine Roof Strata,* **61F33.**

Oppelt, W. H., and Kube, W. R.: *Bench-Scale Experiments on Low-Temperature Carbonization of Lignite and Subbituminous Coal at Elevated Temperatures,* **61F1.**

Oppelt, W. H., and Gronhovd, G. H.: *Design and Preliminary Operation of [illegible] Fixed-Bed Pressure Gasification Pilot Plant,* **61F18.**

Orlandi, W. J.: *Requirements and Advantages of An All-Belt Mine Haulage System,* **61F9.**

Parisi, C. W.: *Use of High Expansion Foam on an Actual Mine Fire,* **61F70.**

• Peters, J. T., and Shapiro, N.: *Know Your Coal,* **61F62.**

Risser, H. E.: *Adaptability of Illinois Coal for Use in Iron and Steel Production,* **61F30.**

Sallmann, K.: *German Coal Flotation—1960,* **61F80.**

Valeri, M.: *Continuous Mining in the Pittsburgh Seam,* **61F46.**

Washburn, H. L., and McConnell, W. A.: *Design of Loveridge Plant,* **61F58.**

Weimer, W. A.: *Peabody Coal Company's "River King Mine,"* **61F59.**

• Wotring, R. W.: *Lee-Norse Miner in the No. 4 Pocahontas Seam,* **61F63.**

Wright, F. D.: *Maximizing the Profit of a Coal Preparation Plant by Linear Programming,* **61F16.**

ECONOMICS (K)

Douglas, T. B.: *Economics of 5½ Mile Transport Conveyor Belt at Ideal Cement Company's Ada, Oklahoma, Plant,* **61HK28.**

Dubnie, A.: *Transportation of Minerals in Northern Canada,* **61K11.**

Eisemann, E. F., Jr.: *Some Aspects of Competition Between Fuels in the United States,* **61K89.**

Gritzuk, N.: *Long Haul Transportation of Minerals in Canada's Far North West,* **61HK34.**

Jaworek, W. G., and Schanz, J. J., Jr.: *Fuel Interchangeability—Measuring Its Extent in U.S. Energy Markets,* [illegible]

Lasky, S. G.: *Mineral Self-Sufficiency,* **61K4.**

Lentz, O. H.: *The Depletion Rationale and Recent Political Pressures of Erosion,* **61K91.**

Quinn, F. J.: *Natural Gas and the Competitive Fuel Market,* **61K90.**

Riggs, W. A.: *Transportation Economics of Mineral Commodities,* **61HK19.**

Robinson, M. E., and Kurtz, W. L.: *Competitive Markets—The Fossil Fuels,* **61K23.**

Roetzer, A. A.: *Materials Handling, Transportation, and What Lies Ahead in Packaging in the Cement Industry.* **61HK50.**

• Wilhelmy, O., Jr.: *Water Transportation of Fertilizer Raw Materials,* **61HK75.**

• Young, R. A.: *The Quota System in Mining—Particularly Lead and Zinc,* **61K96.**

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• Forrester, J. D.: *The Future for Educational Training of Mineral Industry Engineers,* **61J98.**

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• Knoerr, A. W.: *What the Mining Industry Expects of Mining and Mineral Processing Engineers,* **61J108.**

• Reed, J. J.: *The Interdependence of Mining Education, Research, and the Industry,* **61J99.**

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• Blais, R. A., and Stubbins, J. B.: *The Role of Mining Geology in the Exploitation of the Iron Deposits of the Knob Lake Range, Canada,* **61I101.**

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Shea, E. P.: *The Use of Geology in Butte,* **61I29.**

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Hay[illegible], M.: *Geologic Mapping with the Aid of Magnetics, Tahawus Area, New York,* **61L13.**

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• Bleimeister, W. C.: *Rock Salt Mining and Economics in the North Central Area,* **61H9[illegible].**

Czel[illegible], J., and O'Brien, W. F.: *Lithium [illegible]rizons,* **61H60.**

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Douglas, T. B.: *Economics of 5½ Mile Transport Conveyor Belt—Ideal Cement Company's Ada, Oklahoma, Plant,* **61HK28.**

Goldman, H. B.: *Urbanization and the Mineral Industry,* **61H84.**

Gray, J. E.: *Specifications for Mineral Aggregates,* **61H82.**

• Golson, C. E., and Newton, D. E.: *Application of Metallurgical Principles, Processes, and Equipment to the Production of Mineral Aggregates,* **61H87.**

Gritzuk, N.: *Long Haul Transportation of Minerals in Canada's Far North West,* **61HK34.**

He[illegible]dall, O. C.: *Conflicts Between Mining and Other Economic Activities—A General View,* **61H74.**

Jackson, T. M., and Jones, R. K.: *The Role of Organic and Inorganic Fibers in Gaseous and Liquid Filtration,* **61H79.**

Kienitz, L.: *Better Aggregate Processing Pays Off,* **61H44.**

Landes, K. K.: *Chemical and Metallurgical Limestone in North Central, Northeastern States, and Ontario,* **61H41.**

• Lemish, J.: *Research in Carbonate Aggregate Reactions in Concrete,* **61H95.**

Maddock, T., Jr., *Quarrying or Mining Versus Water Reservoirs,* **61H31.**

Mussey, O. D.: *Water: Its Role in Mining and Beneficiating Iron Ore,* **61H81.**

Price, W. L.: *Wire Cloth and Perforated Plate for Vibrating Screens* (NSGA Circular #80), **61H71.**

Riggs, W. A.: *Transportation Economics of Mineral Commodities,* **61HK19.**

Roetzer, A. A.: *Materials Handling, Transportation, and What Lies Ahead in Packaging in the Cement Industry,* **61HK50.**

• Wilhelmy, O., Jr.: *Water Transportation of Fertilizer Raw Materials,* **61HK75.**

Williams, V. C.: *Saline Water Conversion Economics,* **61H38.**

Wollman, N.: *Our Future Water Needs—PMPC Forecast vs RFF Estimate,* **61H32.**

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Hoffman, I., and Mariacher, B. C.: *Beneficiation of Israeli Phosphate Ore,* **61B57.**

• Howell, F., and Stoehr, R. J.: *Handling and Drying of Wet Ambrosia Lake Ores,* **61B93.**

Larsen, E. [illegible]: *Blending and Handling of Materials for Agglomeration,* **61B22.**

Lash, [illegible], and Ross, J. R.: *Scandium Recovery from Vitro Uranium Solutions,* **61B51.**

Le[illegible]e, N. M., and Fassel, W. M.: *The Technique of Gas Oxidation During Pulp Agitation,* **61B10.**

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Speers, E. C., and Woodruff, F. G.: *Materials Handling Facilities at the Ray Mines Division Expansion Program,* **61B14.**

Sudbury, M. P., and Petkovich, F.: *Exothermic Hardening of Copper-Nickel Sulphide Agglomerates,* **61B40.**

Takahashi, Y.; Serizawa M.; Miyagawa, K.; and Shimomura, Y.: *New Process in Sintering of Fine Iron Ores,* **61B6.**

Thompson, C. D.; Czako, C. A.; and Violetta, D. C.: *Benefication of Cement Raw Materials by Dwight-Lloyd Processes,* **61B12.**

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• Carpenter, R. H.: *Research in Exploration,* **61AI02B.**

• Bates, C.: *Underground Nuclear Testing Detection, VELA UNIFORM, and Mineral Technology,* **61AI02C.**

• Lyon, R. J. P., and Westphal, W. H.: *Future Trends in Mining and Exploration,* **61AI02D.**

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• Pfleider, E. P., and Dufresne, C.: *Transporting Open Pit Production by the Truck-Ore Pass-Adit System,* **61AO56.**

Stewart, R. M., and MacQueen, C. W.: *The Electric Wheel Truck in Anaconda's Operations,* **61AO84.**

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Ryon, J. L., Jr.: *Underground Use of Ammonium Nitrate-Fuel Oil Explosives,* **61AU25.**

Waples, B. R., Jr.: *Alimak Raise Climber at Iron King Branch of Shattuck Denn Mining Corporation,* **61AU26.**

• Indicates Preprints not available in St. Louis, or those papers received at the Preprint Center after the meeting was in progress.

Personals

Domingo Moreno, formerly New York office manager of Brown & Root Inc., has moved to Lima, Peru, to accept a position with Panamerican Commodities, S.A.


R. W. NEYMAN N. W. STALHEIM

Ralph W. Neyman recently retired as president of Federal Resources Corp. to enter private consulting work. He will also continue his services to the company on a part-time consulting basis. Mr. Neyman has had more than 40 years of mining experience and gained national recognition in the mining field while working for Hecla Mining Co. He left Hecla in 1956 to become president and general manager of Federal Uranium Corp. **Nels W. Stalheim** has been named to succeed Mr. Neyman as president and chief executive officer. He has been serving as chairman of the board since December, 1958 when he resigned as a vice president of The Hidden Splendor Mining Co. to join the company. **Floyd B. Odlum** has been named chairman of the Board of Directors and senior officer. Mr. Odlum is the largest single stock holder of Federal Resources Corp. and has held such interest for several years. Assumption of his present office marks his return to active official responsibility in industry for the first time since his retirement from Atlas Corp. in May 1960.


F. B. ODLUM H. B. EWOLDT

According to a recent announcement from LeTourneau-Westinghouse Co., **Harold B. Ewoldt** has been appointed truck specialist-sales. Prior to joining LeTourneau-Westinghouse, he was project manager for Beacon Construction Co. and before that was with Cerro de Pasco Corp. at the New York office.

David W. Stranway has been appointed assistant professor in the geology department at the University of Colorado. He will carry on research in geophysics in addition to his teaching duties. He was formerly a research geophysicist with Bear Creek Mining Co.

Norman Weiss, milling engineer with American Smelting & Refining Co., has moved his office from Salt Lake City to Tucson, Ariz., 813 Valley National Bldg.

Alfonso S. Ybanez has been appointed general superintendent for both the Masara project and the Sibuguey project of Samar Mining Co. which necessitated his moving from Davao City to Zamboanga City, Philippines.

J. E. Worthington has been transferred from Tucson office of Bear Creek Mining Co. to its coordinating unit in Salt Lake City to work on research problems applicable to exploration geology.

Barry Crowston was recently appointed assistant director of technical information for Climax Molybdenum Co. Prior to his association with Climax, Mr. Crowston worked for four years as an apprentice metallurgist at the Appleby-Frodingham branch of U.S. Steel Corp. in Scuthrope, England. Following this he attended the University of Nottingham and graduated with honors.

Bernard M. Pratte, formerly general manager of the Pacific Div., Harnischfeger Corp., has been appointed assistant to the president and moved from the West Coast to company headquarters in Milwaukee.

The board of directors of Western Gold & Uranium Inc., recently elected **Lee Ackerman** president and director of the company. Mr. Ackerman is well known in the Southwest as a banker, real estate developer, investment counsellor and officer and director of many corporations.

After completing the construction of an $18 million pulp and paper mill in Cali, Colombia for W. R. Grace & Co., **Charles O. Perlwitz** resigned as resident manager to take a similar position with Beloit Iron Works, Beloit, Wisc.

R. H. Hughes was recently named chairman of the board of Clinchfield Coal Co. and will transfer his headquarters from Dante, Va. to New York. **C. Kyle Tieche** was elected president of the company to succeed Hughes. Mr. Tieche had been vice president.

personals

continued

American Zinc, Lead & Smelting Co. recently announced that **D. A. Underwood** has joined the firm to fill the newly-created position of assistant director of minerals beneficiation for the parent company and its subsidiaries. He had formerly been with the American Zinc organization, serving for 15 years in the chemical and metallurgical departments at Metaline Falls, Wash., and as mill superintendent there for five years. During the past year Mr. Underwood was a member of the technical service and development staff of Dow Chemical Co.

After five years in Chile where he was a geologist for Andes Copper Mining Co., **Eugene W. Wheeler** has returned to the U.S. to take a similar position with Bear Creek Mining Co. in Tombstone, Ariz.

M. Richard Halstead, Jr., formerly a mining engineer with Pittsburgh Pacific Co., has taken the same post with Tidewater Oil Co.

Roderick G. Murchison has gone to Korea on a U.S. Bureau of Mines assignment. He was transferred from Laos when the U.S. mining advisory program there was discontinued due to political and military difficulties. Mr. Murchison expects to remain in Korea until May, 1962.

George A. Jump has taken the job of metallurgical test engineer with American Smelting & Refining Co. at its Mission Unit in Sahurita, Ariz. Prior to that he was research metallurgist for the Raw Materials Research Division, U.S. Steel in Provo, Utah.

Norl Hamilton has been promoted to vice president and special assistant of the Organics Div., Olin Mathieson Chemical Corp. This is a newly created division which includes explosives, solid propellants and organic chemicals. Mr. Hamilton was formerly vice president—explosives and solid propellants—at East Alton, Ill. With the assumption of his new responsibilities he has moved to the firm's New York offices.

Gov. Otto Kerner of Illinois recently announced the appointment of **William J. Orlandi** as director of the state's Dept. of Mines and Minerals. Mr. Orlandi was formerly assistant vice president of Peabody Coal Co., St. Louis Div.

Allen S. Crowley has obtained a contract for drilling and blasting under T. L. James & J. A. Jones, prime contractors for Beaver Dam on the White River near Eureka Springs, Ark. This is a $15 million Corps of Engineers project.

After almost 22 years of working in South and Central America (for the past four years he was chief engineer and geologist for La Luz Mines Ltd. in Nicaragua), **Nicolaas de Voogd** has returned to Holland to do consulting work.

Fred H. Howell, formerly chief geologist for Duval Sulphur & Potash Co., has left the company to follow other interests in northern California and will be available for consulting work in the field of mining geology.

Carlos A. Lares has become resident engineer of the Naricual coal mine, Corporacion Venezolana de Guayana. He was formerly employed in the company's raw materials department. In his present position he is preparing the mine to supply coal to the government's steel plant beginning early next year.

Robert D. Lindberg, formerly mine manager for Dennison Mines Ltd., has become production manager for International Minerals & Chemical Corp. (Canada) Ltd. at Esterhazy, Sask., Canada.

Following his service in the U.S. Marine Corps, **D. A. Penny** has gone to work for Alabama By-Products Corp. as a mining engineer.

Wesley E. Bryer has been appointed an instructor in geology at Clark University for the current academic year. He had taught geology at Hunter College in 1958 and recently has been doing work at Columbia University for his doctorate.

L. H. Chalfant, manager of Bethlehem Mines Corp., has been named chairman of the program committee for the 1962 Coal Convention of the American Mining Congress.

Howard G. Kraus has taken a job with Boeing Airplane Co. in Seattle. He was formerly assistant city engineer of Arcata, Calif.

Alfred S. Harvey, former senior plant engineer for General Dynamics—Astronautics, is presently an engineer for R.C.A. Service Co. working at Beale A.F.B. — Titan Project in Marysville, Calif.

Richard W. Lottridge, Lottridge-Thomas & Associates, Salt Lake City, was one of a panel of speakers at the Colorado Bar Association's Mineral Law Section meeting held October 12 to 14 in Colorado Springs. The panel discussion covered conflicts between oil and gas leases and mining claims.

George A. Blowers, a director of the Export-Import Bank during the Eisenhower Administration, was recently elected to the new position of vice president—finance of U.S. Beryllium Corp.

John L. Green has gone out to the Philippines on a three-year contract with Santa Mesa Drilling Co. (Atlas Mining Co.) as an assistant drilling superintendent. He was formerly a branch manager for Sprague & Henwood Inc.

Karl E. Gustafson, chief mining engineer, Pierce Management Corp., is returning to India to continue his work as consultant to the World Bank on the loan to the Indian coal mining industry.

Hidden Splendor Mining Co. recently announced that **Phillip L. Merritt** has joined the company as a vice president and moved to Salt Lake City from New York where he had carried on a consulting practice for the past two years. Dr. Merritt directed exploration for the AEC and was geologist in charge of procurement for the Manhattan Project.

P. L. MERRITT

G. M. MEISEL

George M. Meisel, ore beneficiation engineer, has joined Kaiser Engineers as a development engineer in the mining and minerals division. He will be responsible for development of new metallic and nonmetallic minerals engineering and construction projects for the company throughout the U.S. and Canada. He was formerly project manager for Kennecott Copper Corp.

The American Arbitration Assn. recently announced the appointment of **Hugh M. Wolflin,** a consulting engineer specializing in industrial accident control, to its national panel of arbitrators. Mr. Wolflin, whose offices are in Whittier, Calif., will be available to serve in disputes concerning the performance of commercial contracts.

Carl Tolman, vice chancellor and dean of faculties at Washington University, St. Louis, has been appointed acting chancellor until a permanent chancellor is appointed to succeed the recently retired **Ethan A. H. Shepley.** Mr. Tolman will continue as dean of faculties, a position he has held since 1954.

Allis-Chalmers Mfg. Co. recently announced the appointment of **Wray A. Shockley** as manager of the pyroprocessing machinery section to succeed **C. E. Burnett** who was named manager, process engineering, in the firm's new cement industry department. Mr. Shockley has been with Allis-Chalmers since 1953 and was sales manager of mineral processing machinery before being named to his latest post.

After three years as a research associate at the Mines Experiment State, University of Minnesota, **James Novotny Gundersen** has accepted the post of assistant professor of geology at Los Angeles State College. He will be responsible for developing courses in economic and mining geology, mineral beneficiation and engineering geology. He also hopes to renew his consulting services in the Los Angeles area.

The board of directors of Mathies Coal Co. recently announced the election of **J. S. Whittaker** as president and director of the company. He will continue to hold his position of vice president—operations of Pittsburgh Coal Co., a firm he has been associated with since 1939.

Marshall B. Nunlist, formerly vice president—finance for R. Hoe & Co. Inc., has become vice president of finance and administration for Brush Beryllium Co.

Fred L. Lee has been transferred from Salt Lake City, where he was office manager of Joy Mfg. Co.'s M & C Div., to Los Angeles where he is office manager of the company's Industrial Div.

James M. Wellman, president of Wellman-Lord Engineering Inc., recently went to Israel to discuss with leading phosphate manufacturers plans for expanding that country's output of this mineral. He was accompanied by **Eugene S. Sikora,** vice president of development. They were invited to open negotiations for expanded phosphate and chemical manufacturing processes in Israel with the director general of Negev Phosphates Ltd.

William R. Bolton, chief of all engineering for Wellman-Lord, has returned to the U.S. after an extended stay in Israel spent in consultation with Israeli phosphate officials.

James L. Thornton, formerly manager of coal section—belting sales, Goodyear Tire & Rubber Co., took an early retirement from the company and has gone to work for West Virginia Belt Sales Inc. in the capacity of chief engineer—belting sales.

Mario Soriano, formerly a student at the University of Utah, has joined the Dept. of Public Works of the Commonwealth of Puerto Rico in the division of road design and soil mechanics.

Robert E. Hayes, a sales engineer working out of the New York office of Ingersoll-Rand Co., has been transferred to Grand Junction, Colo., where he covers the western slope of Colorado as sales representative

personals

continued

on mining, petroleum and industrial accounts for the company.

Following graduation from the South Dakota School of Mines and Technology, **John Thomas Gribble** went to Kennecott Copper Corp. where he is a management trainee stationed at the pit in Bingham, Utah.

R. W. Lawson, former branch manager for Ingersoll-Rand Co. in Buffalo, N. Y., has been transferred to the company's New York office to become director of personnel.

John A. Thoms, formerly an instructor of geology at Miami University, Oxford, Ohio, has accepted a similar post at the University of Michigan beginning with the new academic year. He recently completed field work in the Sierrita Mountains in Arizona for his Ph.D. dissertation.

C. E. Ricketts has recently reactivated his old business, Black Hills Ore Research Laboratories, which was more or less dormant while he was technician in the Engineering & Mining Experiment Station of the South Dakota School of Mines and Technology. Some of the services of the firm are: statistical microscopic examinations of placer concentrate and mill products, mineral property examinations, evaluations, explorations and investigations. Mr. Ricketts spent June and July on an exploration and mine examination trip in south-central Mexico. He is presently engaged as consultant and assayer for a new company attempting to reopen the old Silver Queen mine in Galena, S. D.

Gregorio Waissbluth, formerly vice president and manager of operations for Compania de Acero del Pacifico in Huachipato, Chile, has returned to the U.S. to become U.S. representative of the firm in its New York office. He continues as a vice president of the company which is engaged in new improvement and expansion programs under way for its steel plant. The company has an iron ore mine, now under construction and scheduled to start operations in March 1962.

After more than eight years as geologist with the Ground Water Branch of USGS, **Thomas A. Simpson** has become chief of the Economic Geology Div. of the Geological Survey of Alabama, where he heads an intensified program of exploration and research toward the development of Alabama's mineral wealth.

J. G. Poore has accepted the position of superintendent of maintenance at the San Nicolas plant of Marcona Mining Co., in Peru. Mr. Poore was previously general foreman—crushing—Erie Mining Co., Pickands Mather & Co.

B. I. Larsen & Associates, consulting geologists and engineers, moved their offices from Tacoma, Wash. to Seattle. **Byron I. Larsen,** of that firm, is active in the field of mineral exploration and development engineering throughout the Northwest.

M. Dean Kleinkopf, a geophysicist in oil exploration for Standard Oil Co. of California, has been transferred to Denver, where he is in charge of gravity and magnetic operations and interpretations in a ten state area of the Rocky Mountains.

Robert W. Hershiser has become a laboratory technician with USGS. He is in charge of the micropaleontology laboratory in the Paleontology and Stratigraphy Branch at Menlo Park, Calif.

B. G. Dale has returned to England to take a job as mineral dressing engineer with The British Plaster Board (Holdings) Ltd. after a year in Ghana where he was technical

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Use 1961 SME Preprint Coupons for these papers. See p. 1272 for complete ordering information.

reduction assistant for Ariston Gold Mines Ltd.

James Marshall Link, formerly a geologist with Kenmac Nuclear Fuels, is now a mine engineer for Monsanto Chemical Co.

David B. Sapik has been transferred from Dutch John, Utah, where he served as general engineer with the U.S. Bureau of Reclamation, to Lakewood, Colo., where he is an engineering geologist.

Ronald B. Stone, formerly assistant mine manager for The Carey Salt Co., has become senior design engineer for Stearns-Roger Mfg. Co.

Following two and a half years in Chile where he was manager of operations for Empresa Minera de Mantos Blancos, **Walter F. Meckel** has moved to Lima, Peru, where he is a partner in Andean Trading & Investments S.A.

W. J. Shields was recently elected vice president—operations of Rochester & Pittsburgh Coal Co. He has been with the company since finishing college in 1935. Prior to his election he was assistant general manager.

George A. Thiel has retired as chairman of the department of geology at the University of Minnesota. **Preston Cloud, Jr.** assumes the chairmanship of the department at the beginning of the fall term.

A former geophysicist, **William L. Johnson, Jr.,** was recently appointed North Central area representative for Mission Mfg. Co.'s Hammerdril. He will work out of Duluth, Minn.


A. P. NELSON


W. L. JOHNSON, Jr.

Arthur P. Nelson, a mining engineer with USBM, is on assignment in Karachi, Pakistan, where he is serving as USBM advisor on an ICA-sponsored project with the Pakistan Bureau of Mineral Resources. His principal duty is to furnish advice in planning for large scale commercial development and production of minerals in Pakistan.

Paul Mourier-Petersen has been named managing director of Sociedade Tecnica Industrial e Comercial Dorr-Oliver (Brasil) Ltda., a new subsidiary of Dorr-Oliver Inc. He had previously been responsible for Dorr-Oliver operations in Mexico and Central America.

Stanton Walker, director of engineering, National Sand and Gravel Assn. and director of engineering, National Mixed Concrete Assn., was named to honorary membership in the American Society for Testing Materials in recognition of long-sustained service to the Society in both technical and administrative activities and particularly for eminent work in the field of cement and concrete.

Pennsylvania Crusher Div. of Bath Iron Works Corp., recently announced the appointment of **Edgar J. Bersheim** supervisor of its testing laboratory. Mr. Bersheim was previously with the Franklin Institute Laboratories for Research and Development, where he was engaged in testing of all kinds of special machines, hydraulic equipment, instrumentation and pressure vessels.

Huston St. Clair, president of Jewell Ridge Coal Corp. and Jewell Ridge Coal Sales Co. since 1939, was recently elected chairman and chief executive officer of the company. **Robert W. Bruce,** formerly senior vice president of the Pittsburgh National Bank, was elected president, chief administrative officer and a director of the companies.

William C. French Jr., was recently appointed general manager—sales for U.S. Steel Corp.'s National Tube Div., to succeed **Louis W. Mason** who retired after more than 37 years with U.S. Steel. Mr. French was formerly sales manager—Eastern Area.

Obituaries

R. W. Gordon
An Appreciation by
J. Claire Evans

R. W. Gordon (Member 1905), who passed away in Denver on Jan. 12, 1960, was born in Scotland and went to Victoria, B.C., with his family when he was 12 years old. He was educated there.

He came to the U.S. in 1900 and after some short engagements was associated with J.V.N. Dorr in the Black Hills of South Dakota, where Mr. Dorr was perfecting his well-known classifier. Later he worked with Charles Chase at the Liberty Bell property in Telluride, Colo. After a few years with the Gallagher Machine Co. of Salt Lake City, he came to Denver in 1908 and entered on his main life work as vice president and general manager of the Stearns-Roger Co., where he continued until his retirement in 1940.

When the Pueblo flood in the 1920's destroyed the Stearns-Roger plant there, Mr. Gordon organized and built the General Iron Works in Denver and was president of it until he retired.

In his later years he lived at the Denver Country Club and for many years spent his winters at the San Marcus Hotel in Chandler, Ariz.

Mr. Gordon was a modest man of the highest principles, a distinguished engineer, a loyal friend and an ardent golfer. He had many friends throughout the U.S. and Canada in the engineering profession.

One of the nicest tributes he received was given by a fellow Scotsman at a dinner in his honor when he retired. George Crombie said, "Tonight I have the great honor to address the Chief of our Clan. Why do we gather here to honor this gentleman? Because he has won the respect and love of every member of the Stearns-Roger organization. How did he accomplish this? He built the foundation of his life upon three great principles—honesty, integrity and love of his fellow man.

"As we all know, there is a brave little country far across the sea called Scotland whose sons have made her immortal in history, song and poem. Among them are . . . and Robert Gordon.

"The words of Robert Burns best express our sentiments toward you, sir:

'Princes and lords are but the
breath of kings—
An honest man is the noblest
work of God.'"

Hubert O. DeBeck (Member 1933) died of a heart ailment at the age of 56 on July 31, 1961, in Johnson City, Tenn., where he had made his home since 1959. He was a native of Brookville, Ind., and was educated at the University of Cincinnati where he graduated as a geological engineer. He was active in both private industry and government service, as well as having served several years on the engineering staff of the University of Texas at Austin. During World War II, he was chief of the mica section of the War Production Board. At the time of his retirement in 1958 he was evaluation engineer for Baroid Div., National Lead Co., Houston. In addition to his membership in AIME, he was a member of The American Ceramic Society and The National Society of Professional Engineers.

Robert Randall (Member 1951) died of a heart attack on Oct. 19, 1960. He was born in Nampa, Idaho on Aug. 1, 1908. He began his career gold dredging for various companies in Idaho. From 1936-41 he was crushing plant foreman for DeLamar Milling Co. and from 1942-45 he worked for Consolidated Freightways. In 1946 he went to Chuquicamata, Chile to work for Chile Exploration Co. At the time of his death he was crusher superintendent.

J. J. de la Fuente (Member 1948) died Nov. 20, 1960 in Monclova, Mexico, at the age of 56. He was born in Saltillo, Mexico, and after attending primary school in his native country, came to the U.S. to attend high school in San Antonio, Texas. He then attended Texas A & M College, graduating in 1928. For seven years after that he did farming and ranching on his own property. It was not until 1935 that he entered the mining engineering field doing plane-table mapping for Ohio-Mexico Oil Corp. In 1942 he joined Altos Hornos de Mexico working in the engineering department while construction was going on. In 1945 he headed the Raw Materials Dept. His association with the company continued until his death.

William A. Weldin (Member 1918) died at the Delaware Hospital in Wilmington on July 29, 1961. He was 80 years old. He was born in Connellsville, Pa. and was a graduate of the University of Pittsburgh. For the first two years after graduation he worked as a rodman and chainman for practising engineers. From 1902-04 he was a draftsman with L.C. Weldin & W.G. Wilkins, consulting engineers. For the next 11 years he was actively engaged in the design and operation of steel shops, coke plants, coal mines, brick plants and pig iron casting plants for various companies. In 1916 he became a member of the firm Blum, Weldin & Co., practising engineers with offices in Pittsburgh. The firm engaged in a wide variety of civil and mining engineering work. In later years Mr. Weldin carried on a consulting practice in New York.

Necrology

Date Elected	Name	Date of Death
1951	O. Jalmer Anderson	Aug. 20, 1961
1940	J. Gordon Cole	July 15, 1961
1956	K. L. Hamberger	June 31, 1961
1908	George R. Jackson (Legion of Honor)	Aug. 29, 1961
1957	A. B. Lynn, Jr.	June 17, 1961
1931	Herman J. Mutz	Apr. 6, 1961
1920	V. G. Shinkle	Aug. 7, 1961

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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